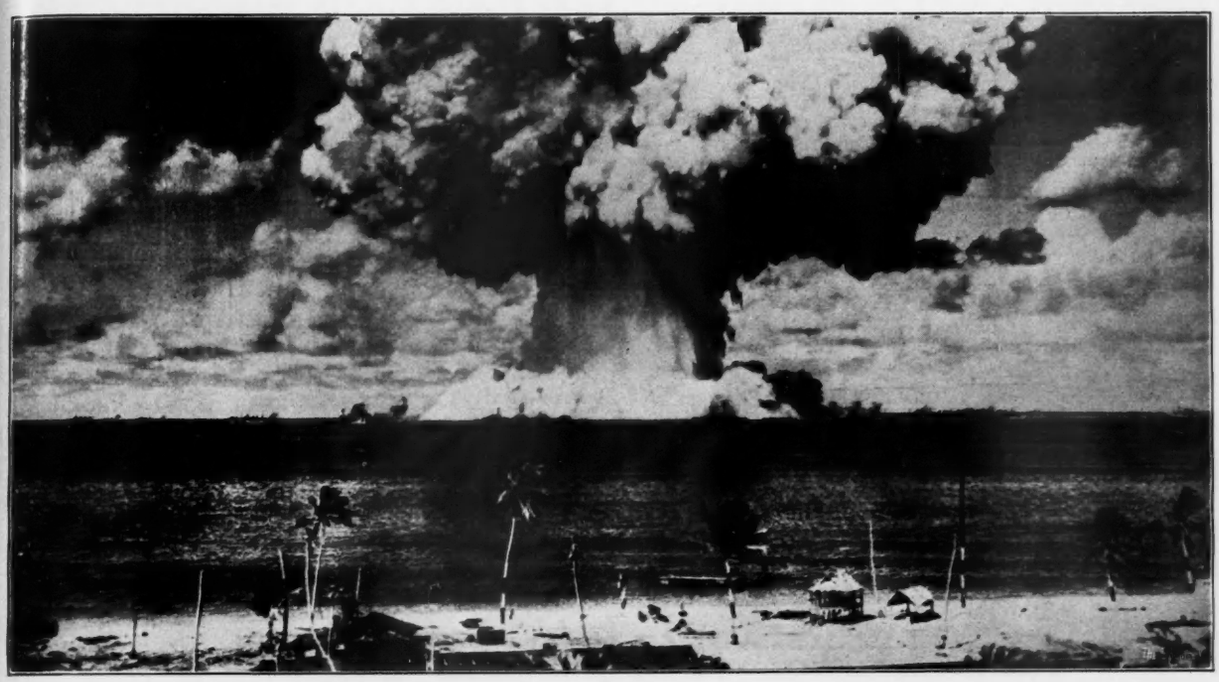
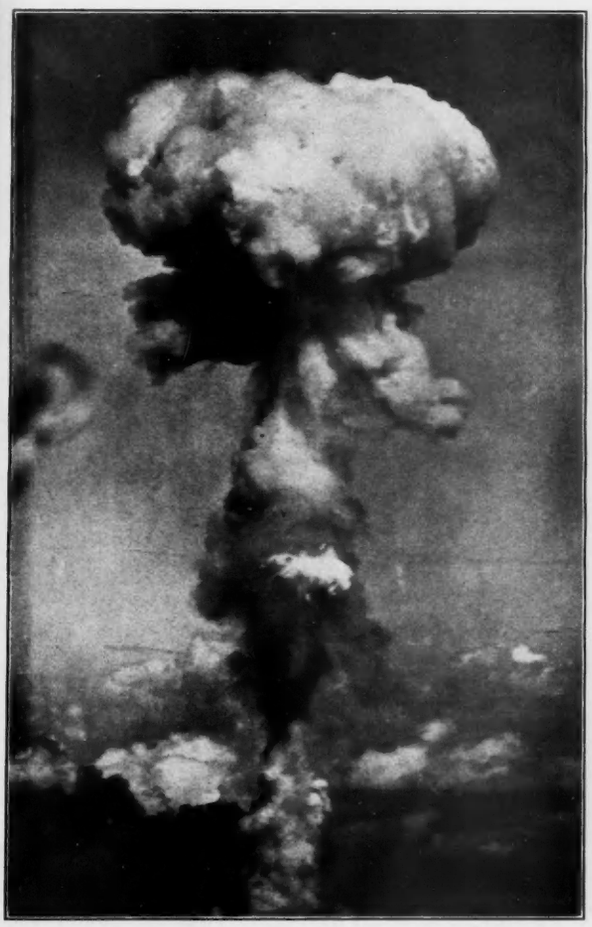
ATOMIC BOMB EXPLOSIONS AT BIKINI

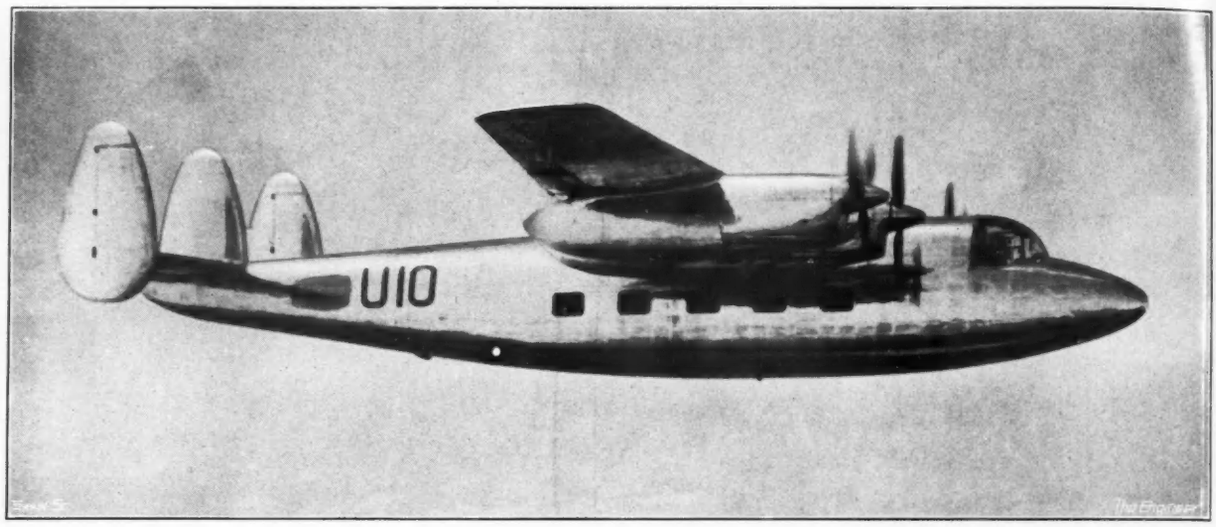


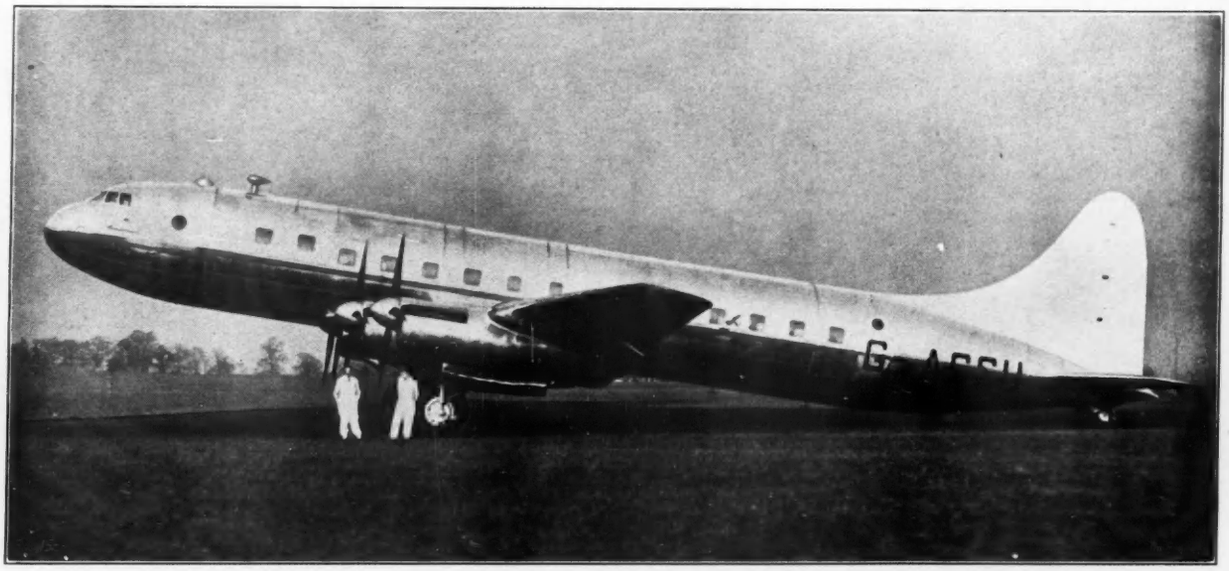


UNDER-WATER EXPLOSION

RADIO-ACTIVE CLOUDS AFTER AERIAL EXPLOSION

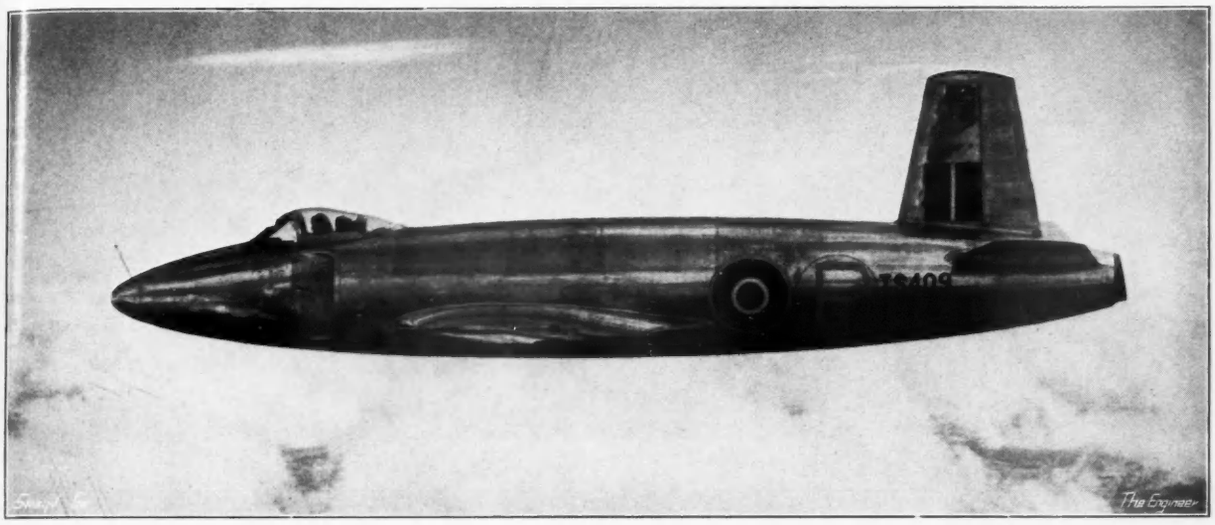
CIVIL AIRCRAFT OF 1946





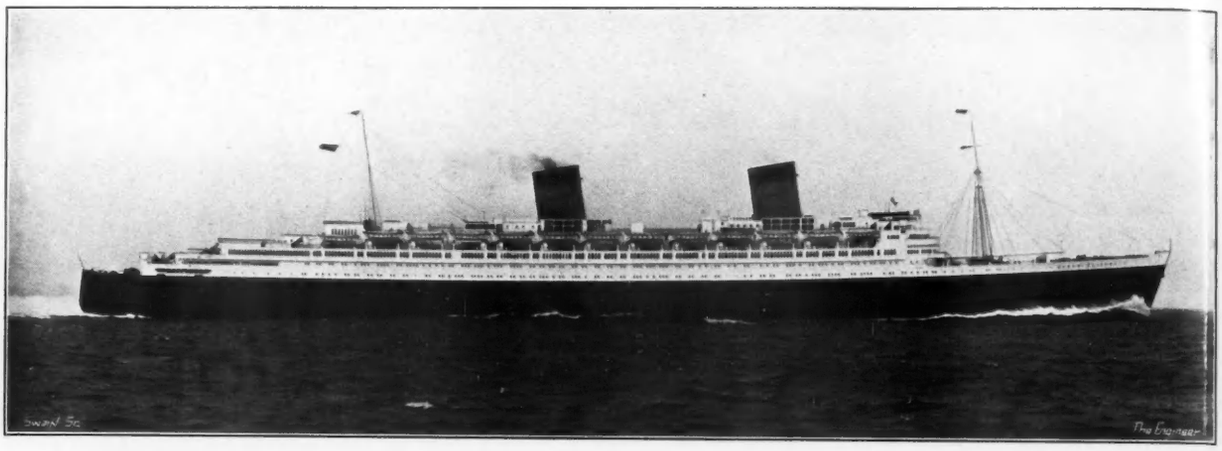
MILES "MARATHON" FOUR ENGINED MEDIUM AIR LINER
HANDLEY PAGE "HERMES" FOUR ENGINED AIR LINER
AVRO "TUDOR II" FOUR ENGINED AIR LINER

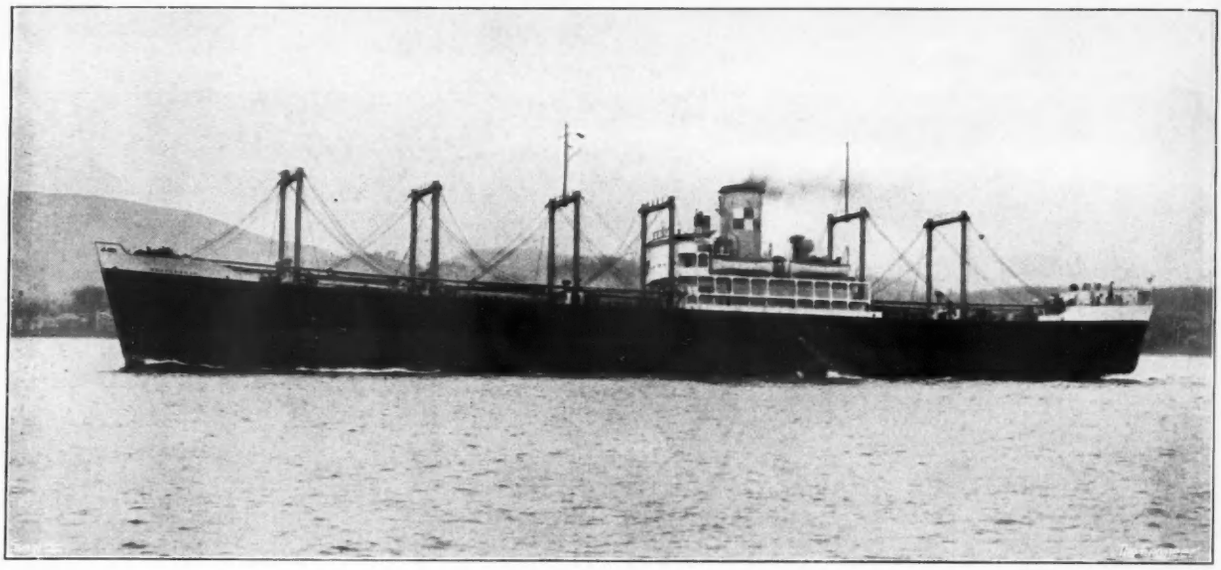
MILITARY AND NAVAL AIRCRAFT OF 1946

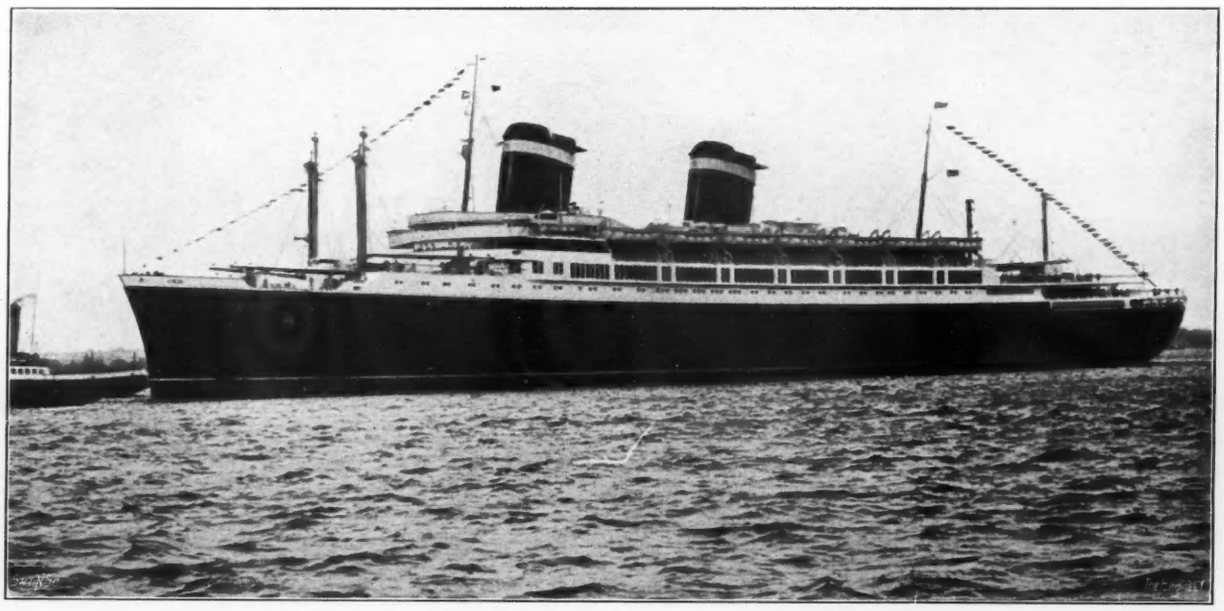


VICKERS-ARMSTRONGS SUPERMARINE JET FIGHTER
FAIREY "SPEARFISH" NAVAL TORPEDO AND DIVE BOMBER
SHORT "STURGEON" NAVAL RECONNAISSANCE BOMBER

PASSENGER AND CARGO LINERS IN 1946





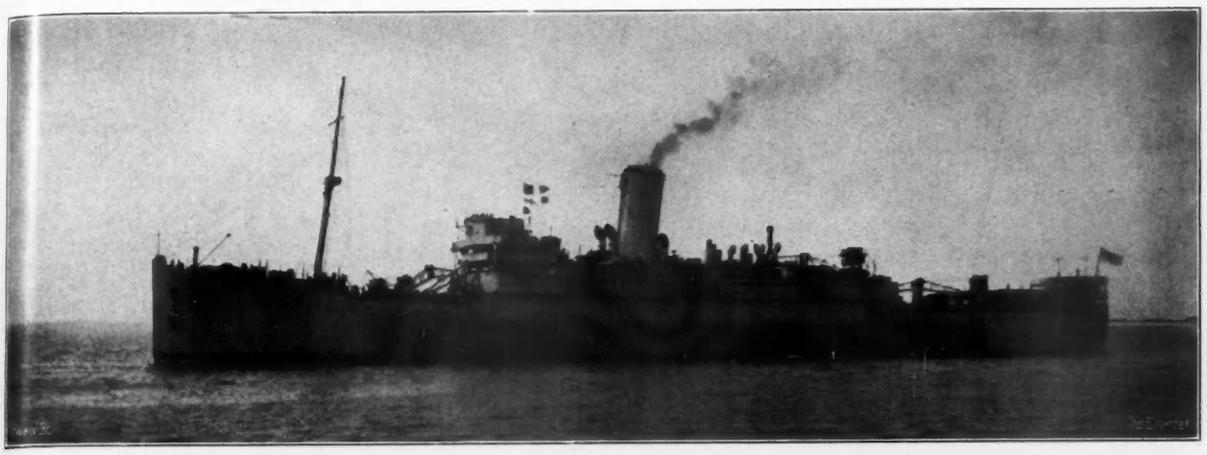


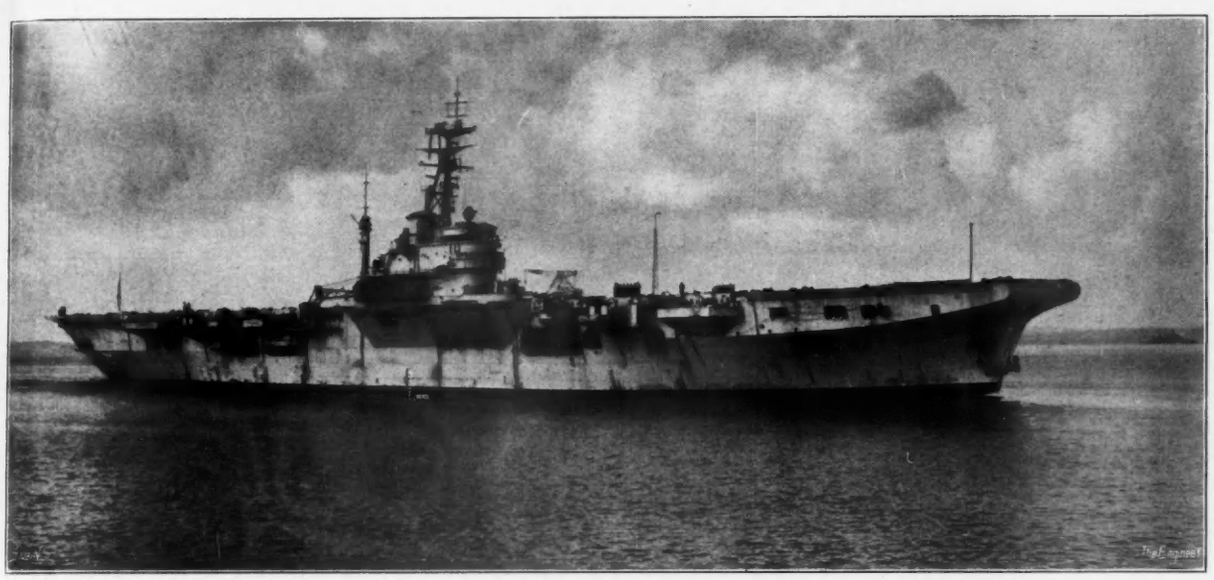
CUNARD WHITE STAR LINER "QUEEN ELIZABETH"

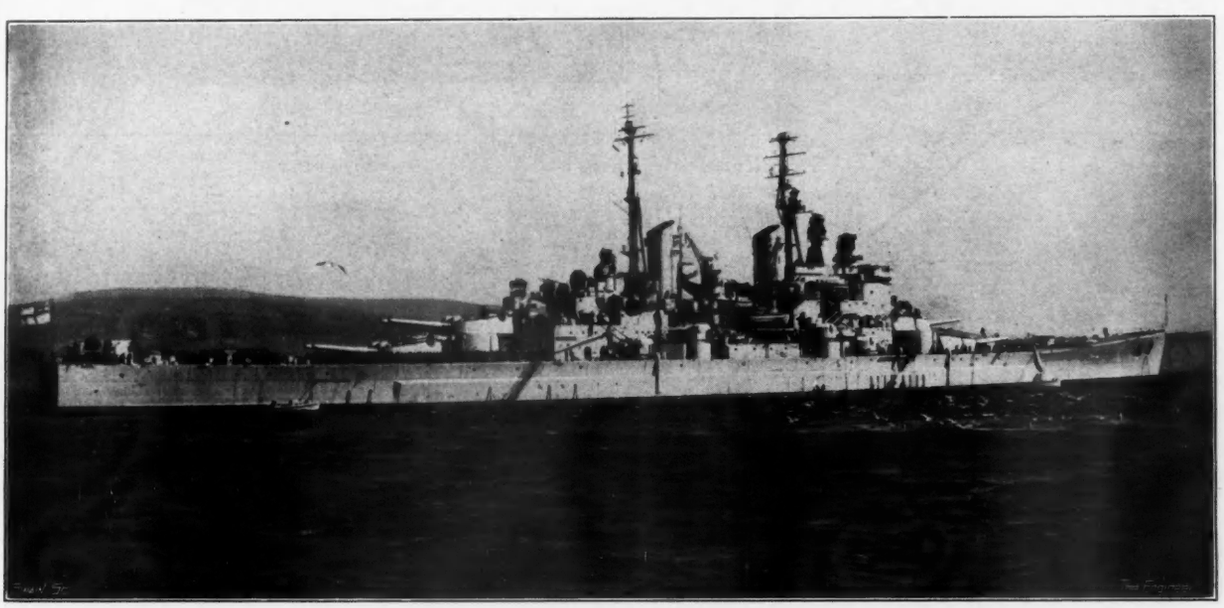
C.P.R. CARGO LINER "BEAVERDELL"

UNITED STATES LINER "AMERICA"

BRITISH WARSHIPS IN 1946





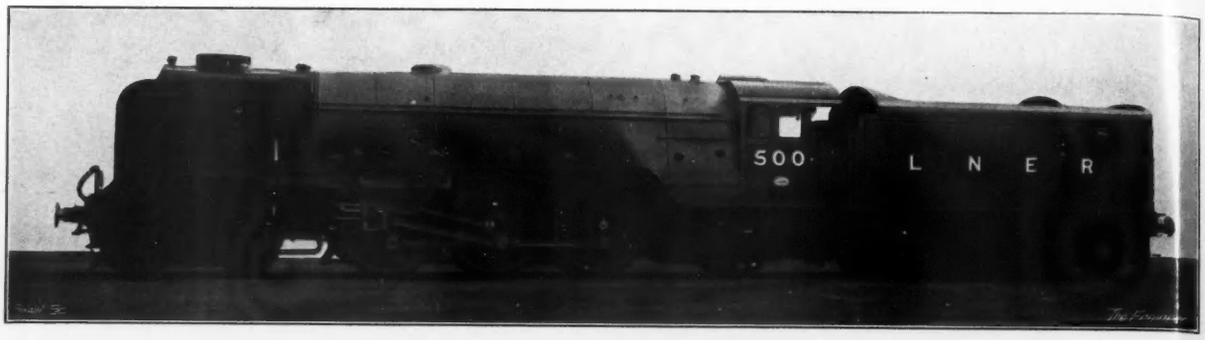


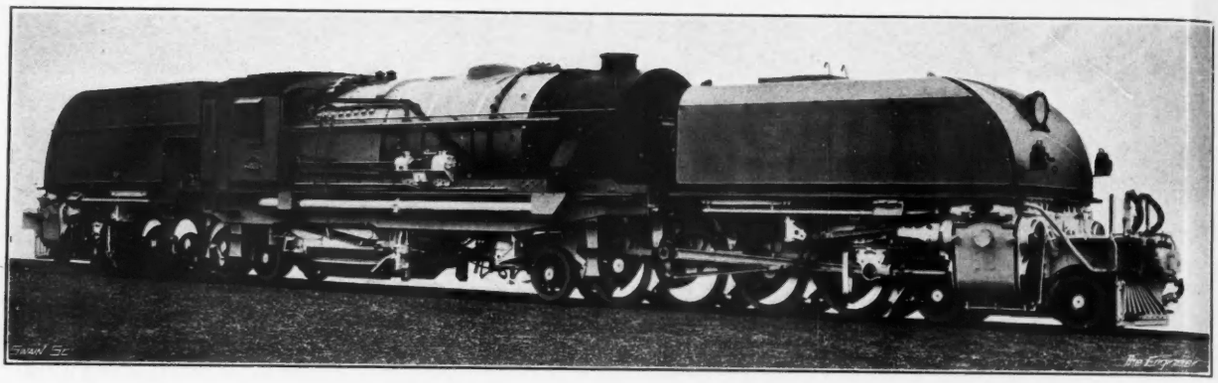
H.M. DEPOT AND REPAIR SHIP "RANPURA"

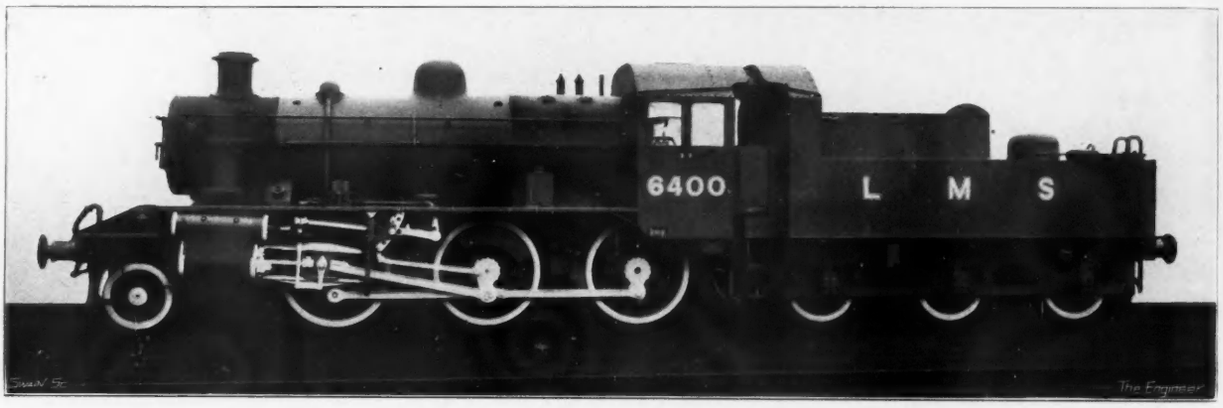
H.M. LIGHT FLEET AIRCRAFT CARRIER "TRIUMPH"

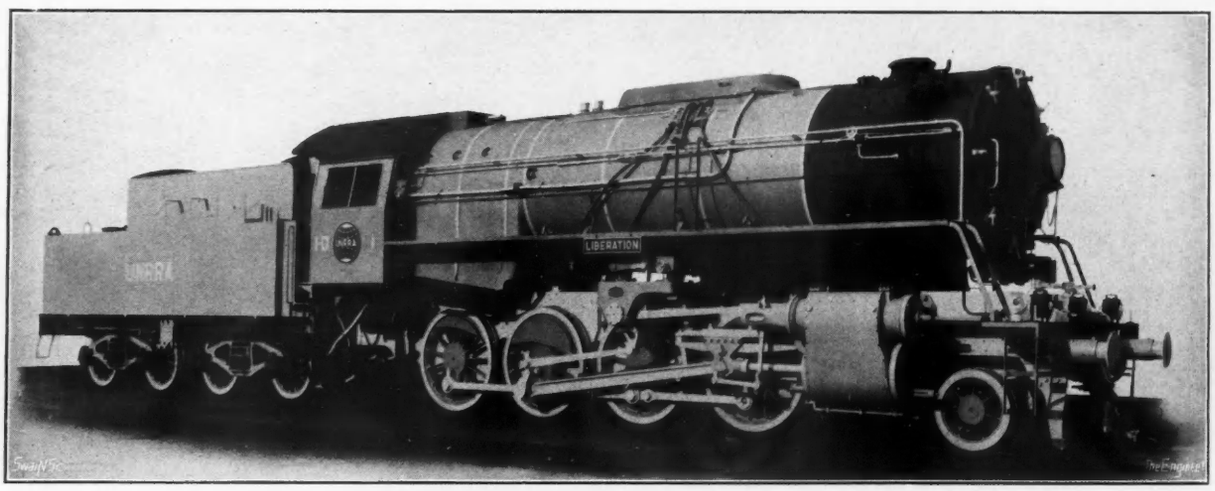
H.M. BATTLESHIP "VANGUARD"

LOCOMOTIVES OF 1946



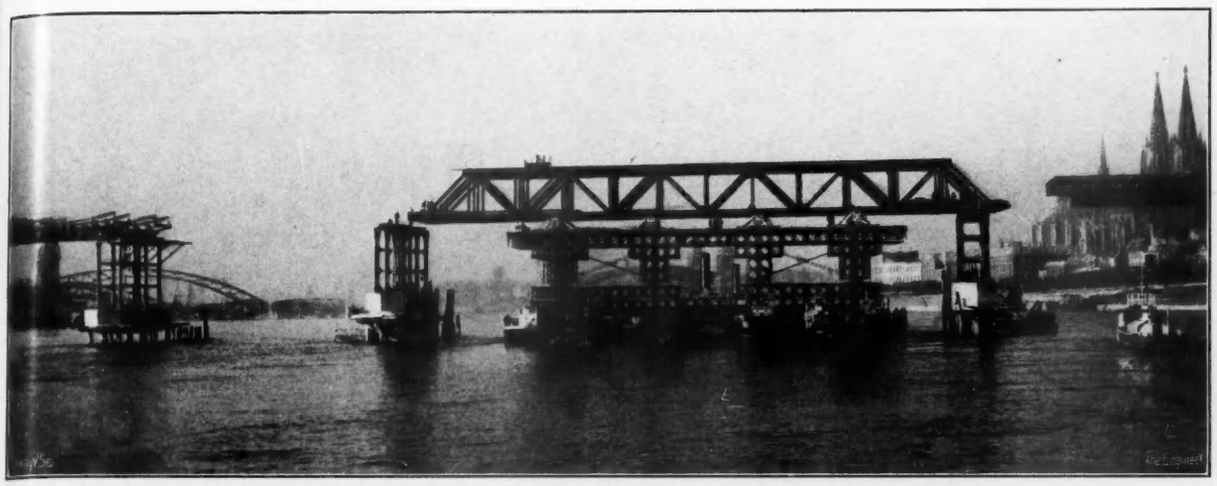


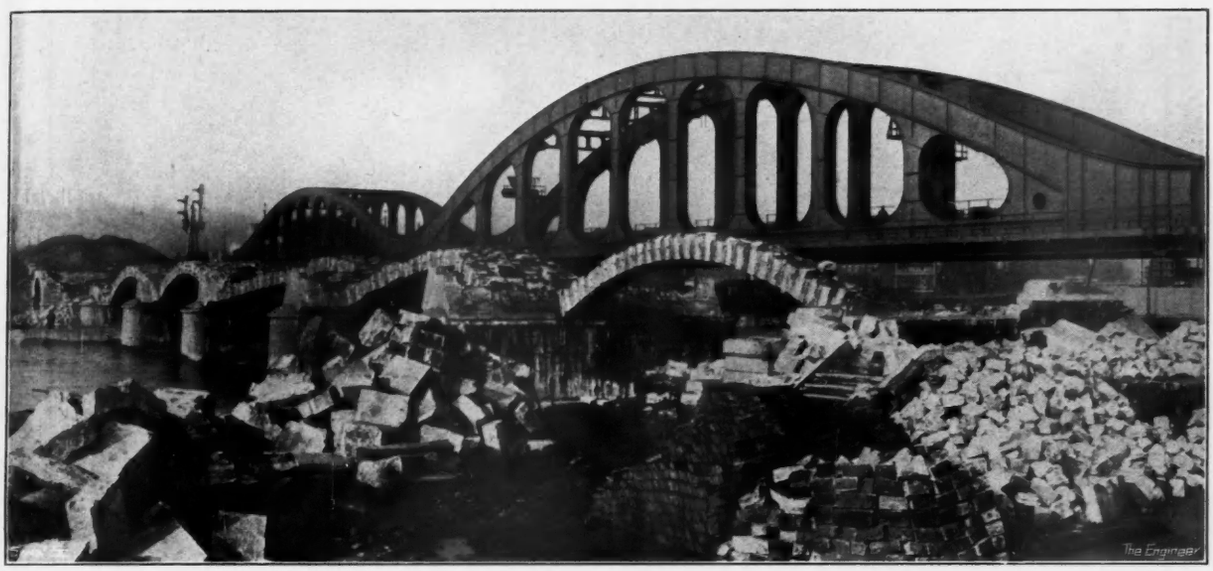




L.N.E.R. SIX-COUPLED PASSENGER LOCOMOTIVE
S.A.R. BEYER-GARRATT GENERAL PURPOSE LOCOMOTIVE
L.M.S. SIX-COUPLED SECONDARY SERVICES LOCOMOTIVE
U.N.R.R.A. EIGHT-COUPLED "LIBERATION" LOCOMOTIVE

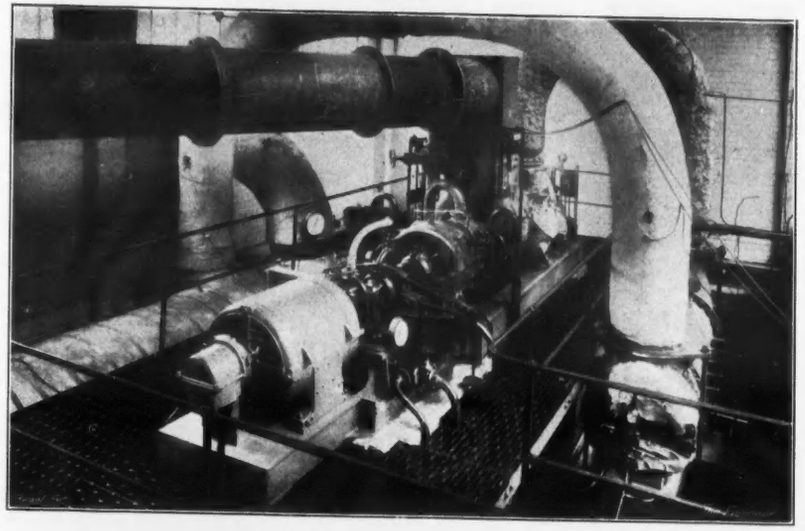
BRIDGE RECONSTRUCTION IN EUROPE—1946

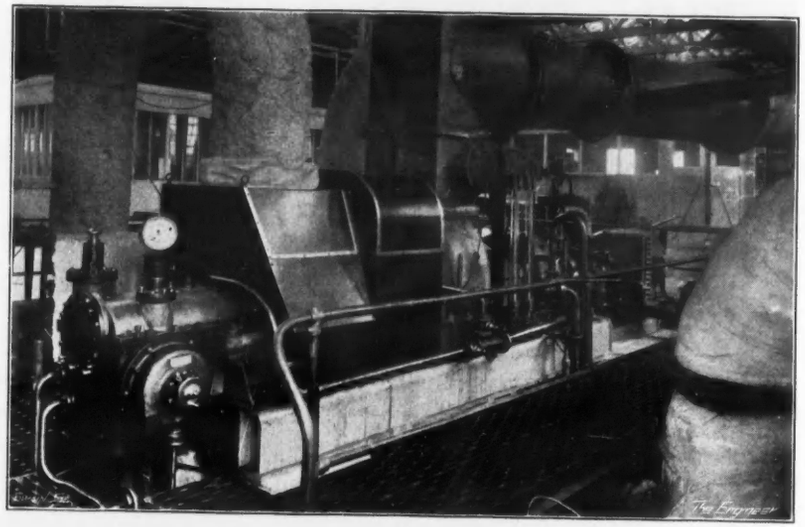


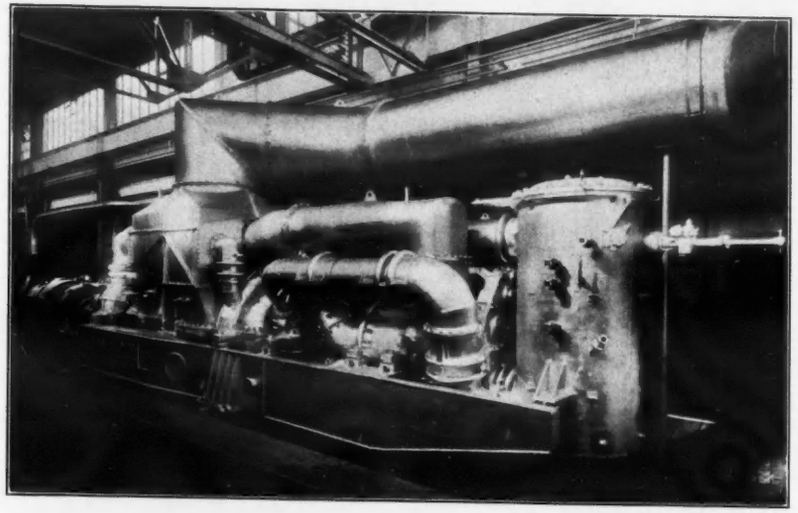


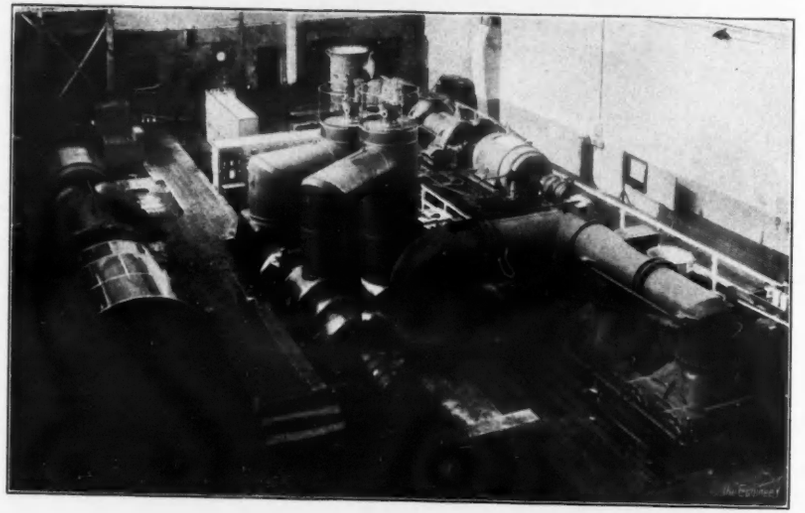
PATTON BRIDGE OVER THE RHINE AT COLOGNE
VAL-BENOIT BRIDGE OVER THE MEUSE AT LIEGE
GALLIENI BRIDGE OVER THE RHONE AT LYONS

GAS TURBINES IN 1946









PARSONS 500 H.P. RESEARCH AND DEVELOPMENT PLANT

BROWN BOVERI 4000 H.P. LOCOMOTIVE PLANT

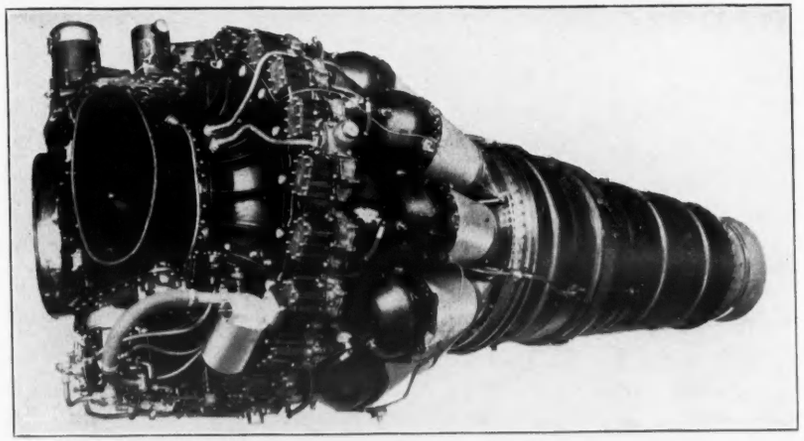
BROWN BOVERI 10,000-KW PLANT ON TEST

GAS TURBINE AERO ENGINES OF 1946

BROWN BOVERI 4000 H.P. LOCOMOTIVE PLANT

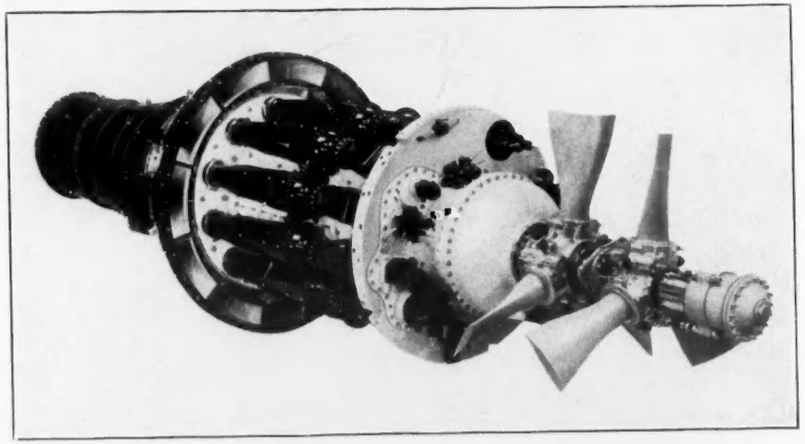
BROWN BOVERI 10,000-KW PLANT ON TEST

GAS TURBINE AERO ENGINES OF 1946



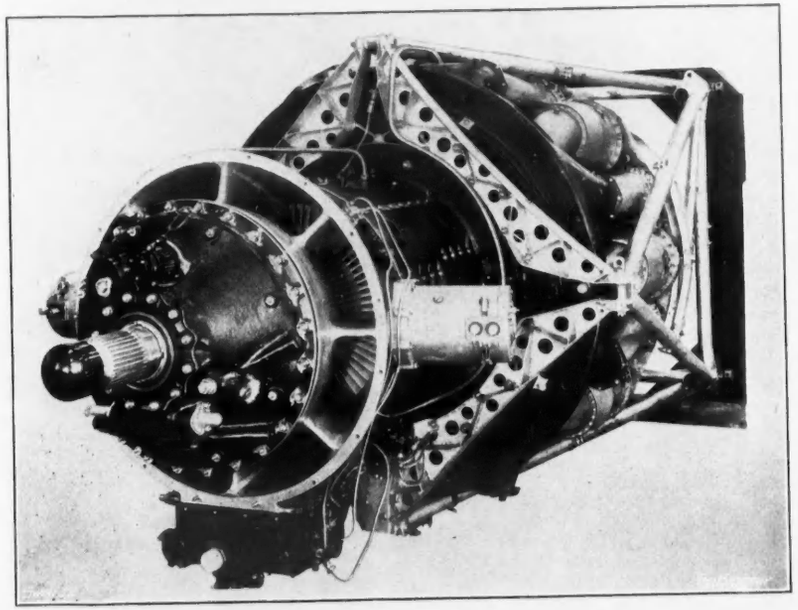
DE HAVILLAND "GHOST" JET ENGINE

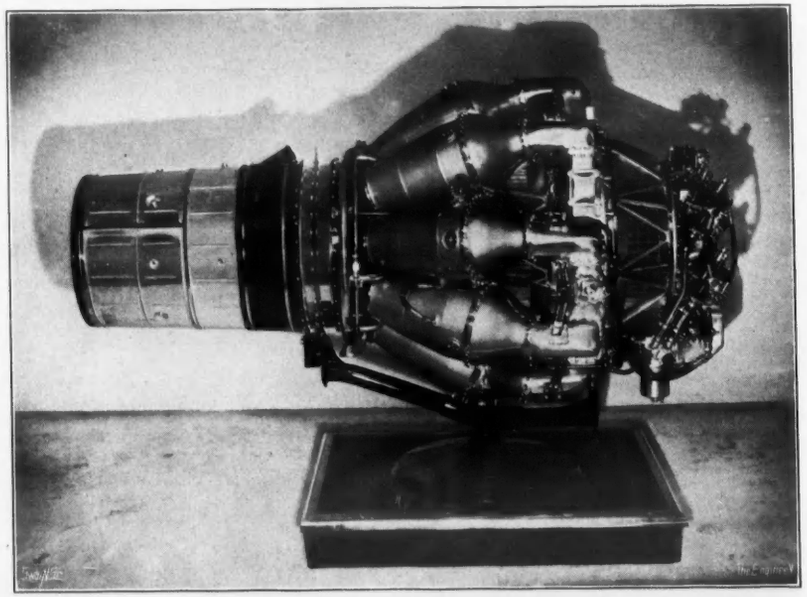
BRISTOL "THESEUS I" TURBINE-PROPELLER ENGINE



ARMSTRONG SIDDELEY "PYTHON" TURBINE-PROPELLER ENGINE

ROLLS-ROYCE "NENE" JET ENGINE

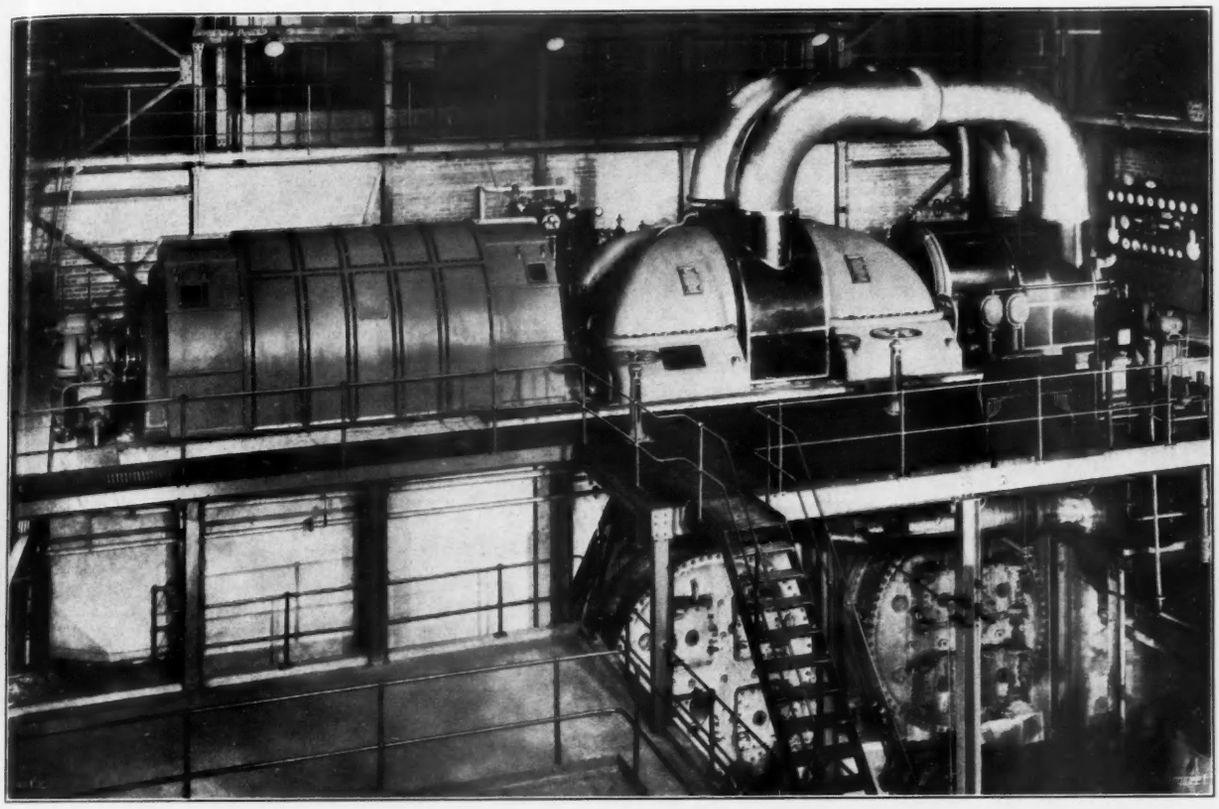


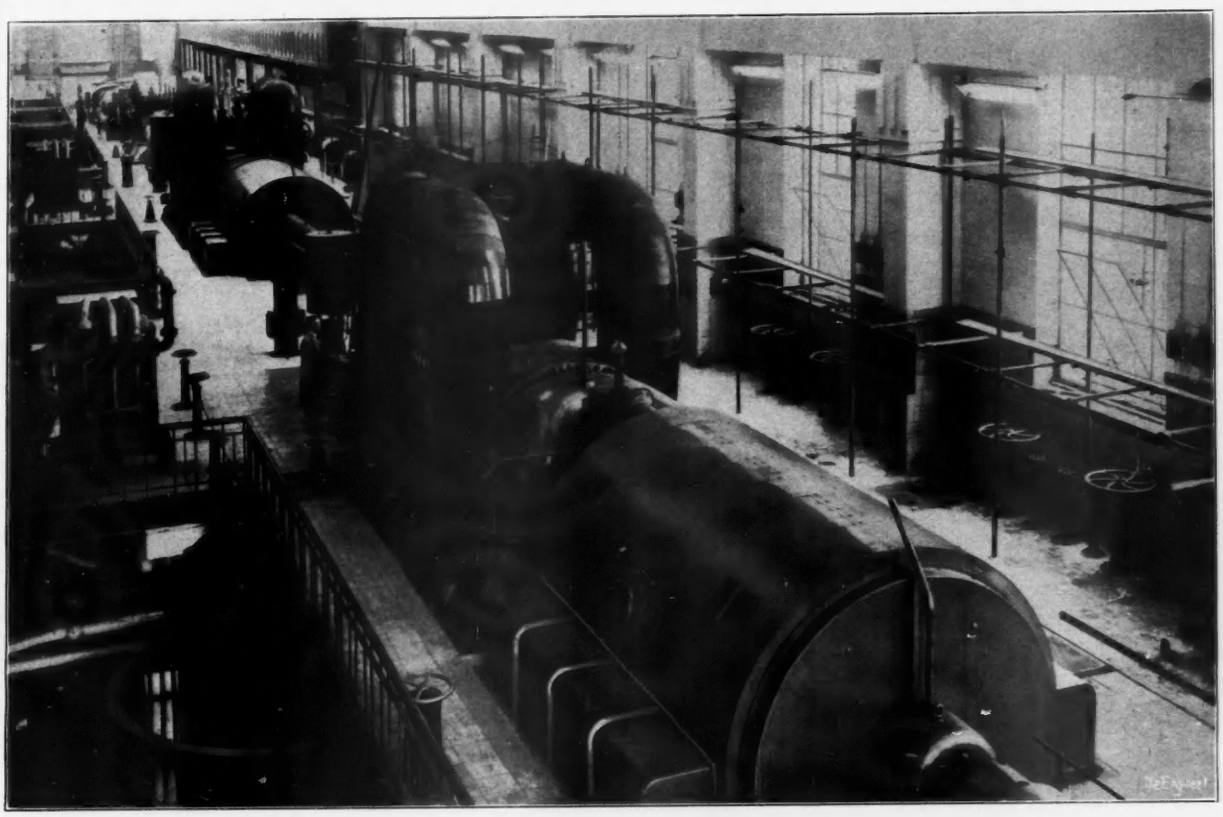


MODERN WARSHIP EQUIPMENT

U.S. CRUISER "HELENA"
H.M. BATTLESHIP "HOWE"

TURBO-ALTERNATORS OF 1946

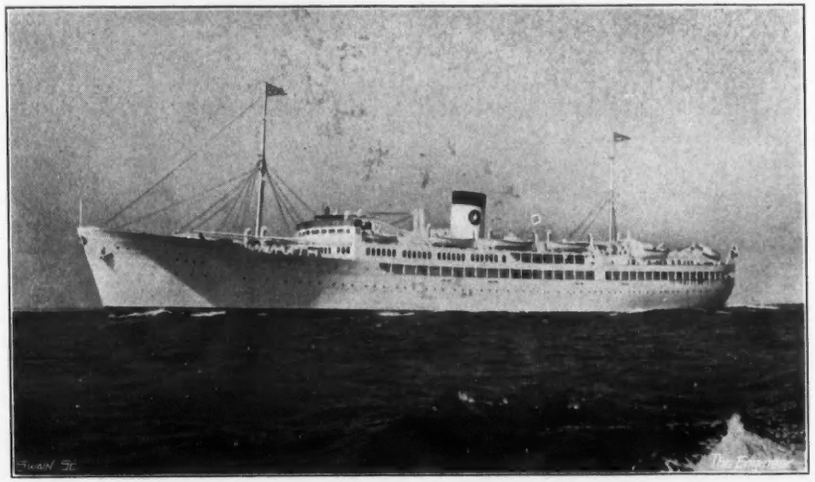




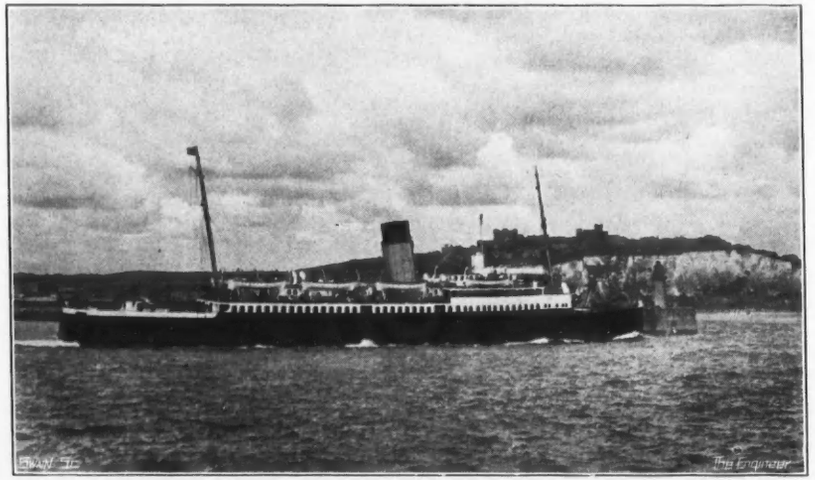
G.E.C. 30,000-KW SET AT SCULCOATES POWER STATION

B.T.H. 30,000-KW SET AT WILLOWHOLME POWER STATION

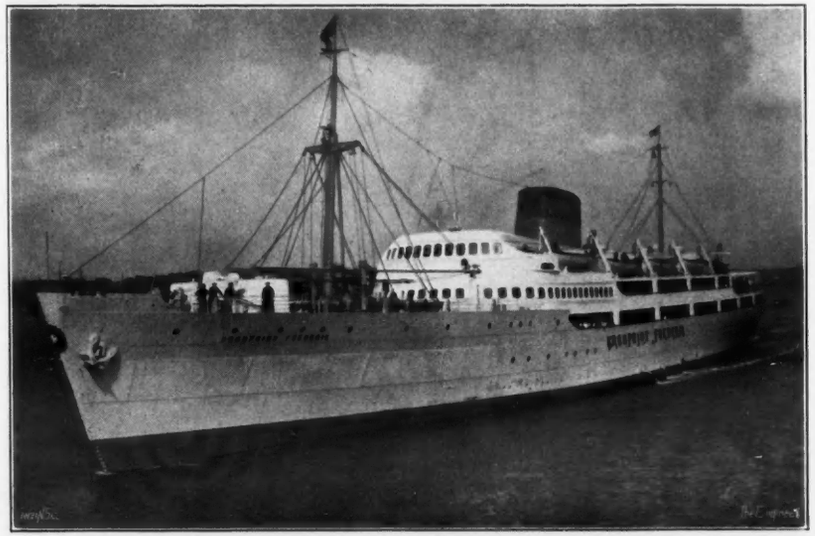
NORTH SEA AND CROSS-CHANNEL SHIPS OF 1946



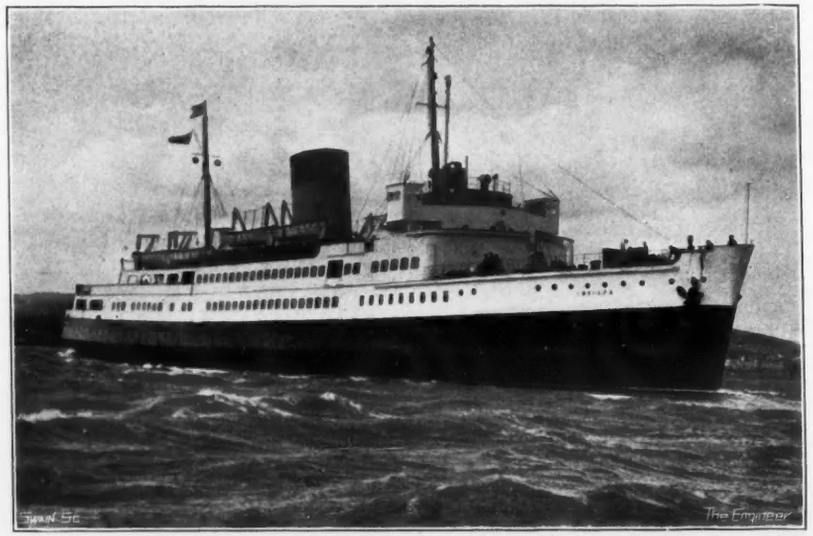
SWEDISH LLOYD MOTOR LINER "SAGA"



SOUTHERN RAILWAY S.S. "CANTERBURY"



UNITED STEAMSHIP M.V. "KRONPRINS FREDERIK"



SOUTHERN RAILWAY S.S. "INVICTA"

SOUTHERN RAILWAY S.S. "INVICTA"

A Seven-Day Journal

The New Year Honours

In the New Year Honours List, to which reference was made on this page in our last issue, it was announced that Sir Ernest Simon, Sir Walter Layton and Mr. Charles Dukes had become Barons. Sir Ernest Simon, it may be recalled, is actively associated with the engineering industry as governing director of Simon Carves, Ltd., and Henry Simon, Ltd. He is chairman of the Fuel Advisory Council and the Manchester University Council, and is a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. Sir Walter Layton is also well known throughout industry, having served as Director-General of Programmes and Chairman of the Executive Committee of the Ministry of Supply, chief adviser on Programmes and Planning Ministry of Production and head of the Joint War Production Staff. Mr. Charles Dukes has for many years been a prominent trade unionist. He is the General Secretary of the National Union of General and Municipal Workers, and last year served as Chairman of the Trades Union Congress. He has been a member of the T.U.C. General Council since 1934. The Honours List also stated that Sir John Forbes Watson had been created a K.C.M.G. Sir John has been Director of the British Employers' Confederation since 1921. During the war he served on the Minister of Labour's Joint Consultative Committee, the Joint Advisory Committee to the Production Executive of the War Cabinet and the Minister of Production's National Production Advisory Council. Sir John is also Vice-Chairman of the governing body of the International Labour Office. At the end of last week it was announced that the King had given orders for the promotion to K.C.B. of Mr. Charles Swift Lillicrap, C.B., Assistant Controller, Warship Production, and Director of Naval Construction in the Admiralty.

A Glasgow Engineer-Surveyor's Retirement

On Tuesday, December 31, 1946, Mr. L. C. Davis, the principal engineer-surveyor to Lloyd's Register of Shipping, retired, after completing 37 years of service with the Society. He was succeeded by Mr. A. R. Riddell, recently the senior engineer-surveyor on the Glasgow staff. Mr. Davis started his career with Lloyd's Register in August, 1909, at Glasgow. After some years he moved to Sunderland, where he served until 1924, when he was reappointed to the Glasgow staff. He was appointed principal engineer-surveyor at Glasgow in July, 1944. His wide engineering knowledge and experience were much sought after, and were highly valued by the many clients of Lloyd's Register on the Clyde. Mr. Riddell, who has been appointed principal engineer-surveyor, has had a large and varied experience in the service of the Society, in the United Kingdom, the Far East and in Canada. Mr. Riddell is succeeded in the office of senior engineer-surveyor by Mr. T. D. Shilston.

Institution of Mechanical Engineers

The Institution of Mechanical Engineers will reach the centenary of its foundation this year, and plans are being completed by the Council to celebrate the event during the week beginning June 8th. On Sunday afternoon, June 8th, a Thanksgiving Service will be held in Westminster Abbey, and on the following afternoon the Centenary Conference will be formally opened at the Central Hall, Westminster, by the Lord President of the Council. During the remainder of the week the mornings will be devoted to technical meetings dealing with twelve main branches of mechanical engineering activities, and in this series of meetings some thirty-six short lectures are to be given by engineers distinguished in each field, collaborating in many cases with a number of co-authors. The afternoons will be occupied by visits to places of engineering interest in or within reasonable access of London and it is possible that some special visits may be arranged for ladies accompanying members. On Monday evening, June 9th, the President will hold a reception at the Science Museum, South Kensington, where a special exhibition is to be arranged illustrative of the progress in mechanical engineering during the century. Another exhibition, associated with George Stephenson, will be held in the Institution building, Storey's Gate, Westminster. Other events of the week will be a reception to be given by H.M. Government, two special evening lectures, and a social function at a West End restaurant or restaurants, for which Wednesday evening, June 11th is being reserved. To conclude the celebrations, a banquet to the delegates will take place at Guildhall on Friday evening, June 13th, at which the Lord Mayor of London and the Prime Minister will be among the principal guests. As hotel accommodation in London is severely restricted, members in the provinces and those overseas are recommended to take immediate steps to secure reservations.

An Anglo-French Shipping Agreement

On Friday, January 3rd, an agreement was signed at the Ministry of Transport in London between the Governments of the United Kingdom and the French Republic, constituting a final settlement of the bulk of outstanding accounts for the use of each country's merchant shipping by the other during the recent war and for compensation for loss or damage, &c. The agreement was signed by Monsieur Jules Moch, Minister of Public Works, Transport and Reconstruction for France, and by Mr. Alfred Barnes, Minister of Transport, for the United Kingdom. The French claims totalled approximately £15,400,000, of which £2,000,000 had already been paid on account. After deductions for British counter-claims and other miscellaneous items, the total amount credited to the French Government was approximately £5,750,000. After signing the agreement, Mr. Barnes spoke of the goodwill which had always prevailed between the Ministry of Transport and those representing French shipping interests, both during the war and since. The agreement, he continued, could not have been concluded under happier circumstances, as representing that goodwill and understanding between the representatives of both Departments. He trusted that the agreement signed was an indication that in the future, in the difficult problems which shipping will have to overcome, the good relationship between the French Ministry and the Ministry of Transport will continue.

Sir Charles Bruce-Gardner's Appointment

It is announced by the board of John Lysaght, Ltd., that Sir Samuel Beale, has expressed his wish to retire from the chairmanship of the company, and that Sir Charles Bruce-Gardner, Bart., M.I. Mech. E., has been appointed chairman in his stead. Sir Samuel Beale, however, retains his seat on the board. At the end of last year it was announced that Sir Stafford Cripps, the President of the Board of Trade, had agreed to release Sir Charles Bruce-Gardner from his post of Chief Executive for Industrial Conversion, in order that he might take up the chairmanship of an important industrial undertaking. Sir Charles will, however, continue to be available for consultation by the Board of Trade on such general industrial matters as the President may refer to him for advice. For many years Sir Charles has been in close touch with the industrial and research sides of the iron and steel industry and in 1936 and 1937 he was Chairman of the London Iron and Steel Exchange. In 1938 he was appointed Chairman of the Society of British Aircraft Constructors, Ltd., a position he continued to hold till 1943. In 1939 he was a member of the Civil Aviation Planning Committee, and served on the Secretary of State for Air's Industrial Advisory Panel. From 1939 to 1941 he served on the Air Council Committee on Supply and on the Air Supply Board. From 1942 to 1943 he was a member of the National Production Advisory Council, while from 1943 to 1944 he was Controller of Labour Allocation and Supply at the Ministry of Aircraft Production.

The Metropolitan Water Board

The forty-third annual report of the Metropolitan Water Board, covering the year 1945–46, was issued at the end of last week, and is of particular interest in that it places on record some of the measures taken to safeguard London's water supply during the war. Amongst them may be mentioned plans enabling limited quantities of drinking water to be distributed if all the Board's works had been put out of action. One thousand specially designed tanks, each holding 500 gallons, were obtained, and arrangements were made with the Ministry of War Transport for lorries to be available at very short notice to carry them. In addition, local authorities and industrial concerns agreed to lend tankers, and in this way there was built up a large fleet of vehicles which, after being sterilised, could be used to carry water to the inhabitants. Special plans were made for supplying hospitals and premises engaged on vital food production. Fortunately, it was not necessary to bring the whole scheme into operation, but on a few occasions after air raids some of the tanks were used to supply small areas.

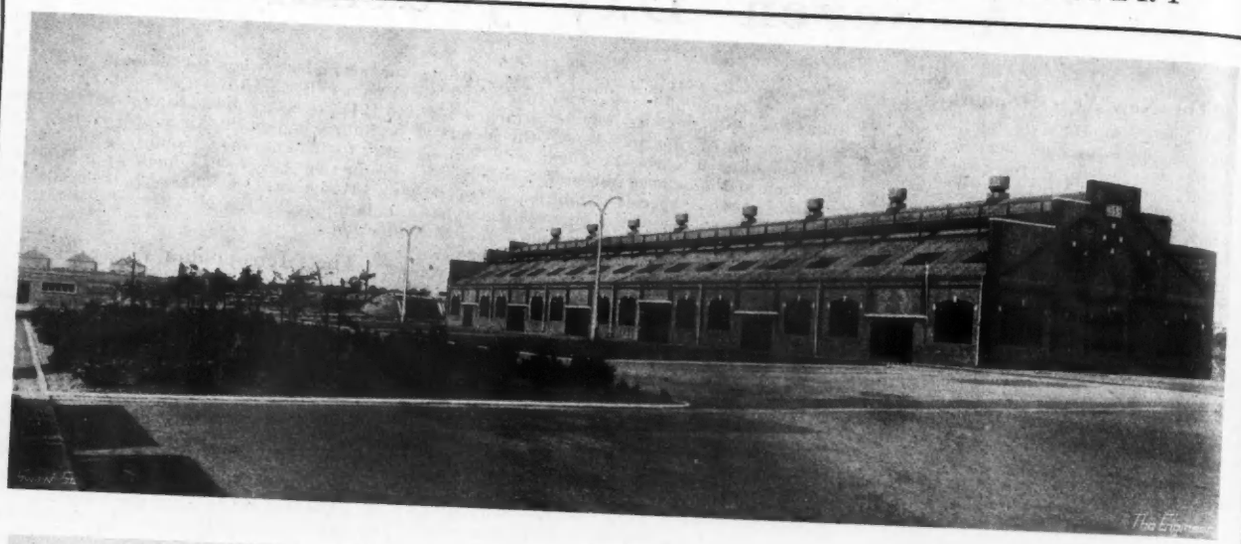
Fire in the Cargo Liner "Corinthic"

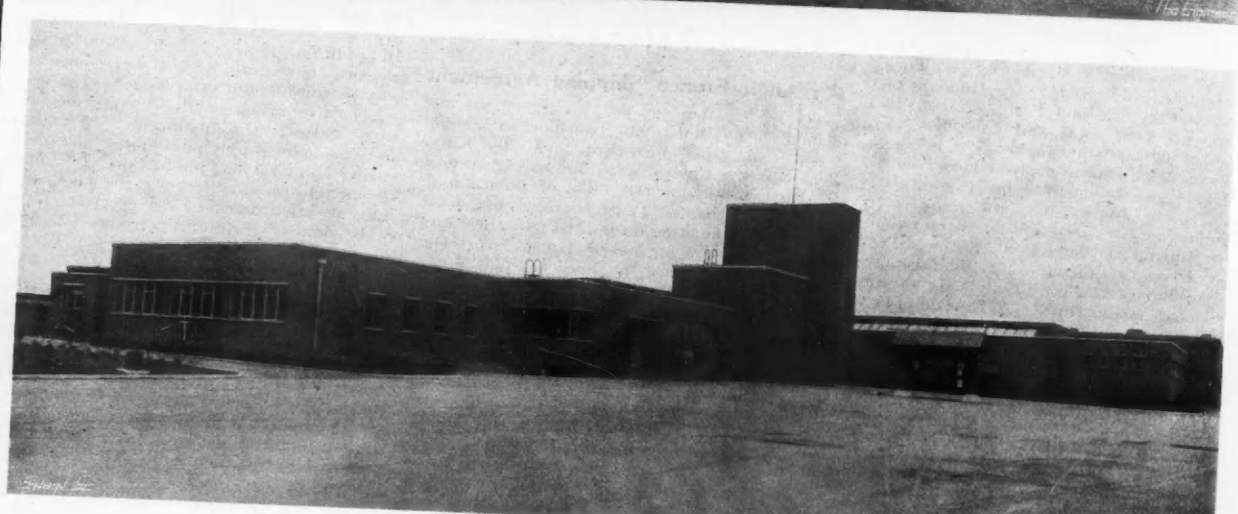
A serious fire broke out early on Saturday morning, January 4th, in the No. 5 hold of the new 10,000-ton passenger and refrigerated cargo liner "Corinthic," which is under construction for the Shaw Saville and Albion Company, Ltd., by Cammell, Laird and Co., Ltd., and was approaching completion in her builder's fitting-out basin at Birkenhead. The fire was discovered by a watchman about 5 a.m., and the N.F.S. was immediately summoned from Merseyside boroughs. Some seventeen fire-engines were employed in fighting the fire, and after over twenty hours' strenuous work it was extinguished about 2 a.m. on Sunday morning. In seeking to put out the fire, which had gained a good hold before the fire brigades arrived, the hold was flooded, and the ship took on a list of 15 deg. to 20 deg. to starboard towards the quayside. For a time part of her superstructure fouled one of the quayside cranes. By Sunday evening the ship was again on an even keel. The damage has not yet been finally assessed, but it may be expected that the completion of the "Corinthic" will be delayed for some months. She was launched at the end of May, 1946, and has cost over £1,000,000.

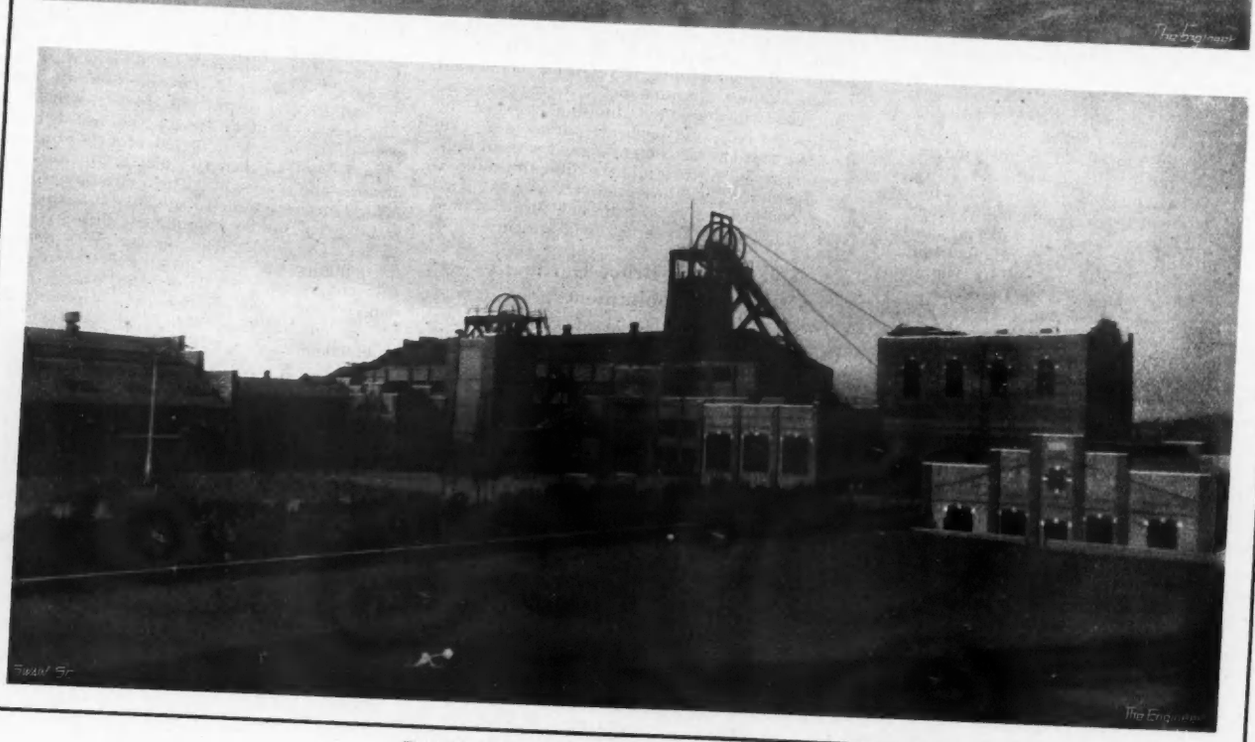
L.N.E.R. Collision at Gidea Park

It is with deep regret that we have to record a serious collision, which took place on Thursday evening, January 2nd, just before midnight, when in dense fog the 10.25 mail train from Liverpool Street to Peterborough crashed into the rear of the 10.28 passenger train from Liverpool Street to Southend, which was just moving out of Gidea Park Station on the London and North-Eastern line. The impact tossed the rear coach of the Southend train through the roof of the station and the second coach of the train was smashed. Seven passengers died as a result of the accident and some forty-six were injured. The driver of the Peterborough train, and his fireman, escaped without injury, and the guard of the Southend train also escaped injury. The accident completely blocked two of the four lines, but by Friday evening practically all normal services were re-established.

MODERN BUILDINGS AT WILLIAMTHORPE COLLIERY







ENGINEERING WORKSHOP AND STORES
CANTEEN, BATHS AND LAMPROOM
SHAFT TOP STRUCTURE AND BOILER HOUSE

The Nationalised Mines and the Coal Supply Situation

By Sir RICHARD A. S. REDMAYNE, K.C.B.

No. I

IT is probable that the year 1946 will come to be regarded as the most momentous in the annals of the coal-mining industry of Great Britain, inasmuch as the great experiment of nationalisation was then inaugurated; and that the treatment of this industry—from the point of view of technique one of the most complicated and difficult of administration—is to be the forerunner of further economic ventures of a like nature in respect of the gas and electrical industries and transport, and, possibly, the iron and steel trade. In the circumstances, one is naturally moved to inquire what are the reasons for so radical a change in ownership and administration, and what are the objectives aimed at.

The Industry Under Private Ownership

When one reflects that the British coal trade has been carried on under a system of private ownership for seven centuries—for coal has been worked in this country as an article of commerce since about A.D. 1215, the date of Magna Charta, which gave security to the right of private property—one naturally asks why, then, bring about a sudden change in ownership? It is not as if under a system of private enterprise the national requirements of suitable coal could not be produced at an economic price, nor that the condition of the workers engaged in the industry was behind that experienced by those engaged in other industries, for, from the year 1845 (when the output was only about 34,600,000 tons), the annual rate of output was almost continuously upward to the year 1913, when it attained the enormous figure of 287,430,478 tons, of which 73,400,118 tons were exported—a greater coal export than that of any other country—and, in terms of value, was 33 per cent of the total value of the coal produced or more than 10 per cent of the total value of all our exports. The average value of a ton of coal in 1913 was about 10s. 2d., a price the lowness of which we will not experience again.

The Causes of the Decline in Output

Since 1913 there has been a gradual decline in the national output of coal, a decline amounting to about 100,000,000 tons, and a shrinkage in export of 65,000,000 tons. Again, one is moved to inquire as to the causes which have brought about this state of affairs, and to ask whether the remedy lies in a change of ownership.

The causes can be stated, briefly, as follows: The advent of two of the greatest wars in the history of the world and the consequential disturbances resultant therefrom. The immediate effect of both wars was to hit the coal-mining industry of the United Kingdom by closing down entirely several important foreign markets and by temporarily or partially disorganising business in many others. The staff of workmen at the collieries became much depleted by reason of the call to the colours, there was increasing cost and scarcity of supply of materials (especially of pit wood) used in coal mining, and though the price of coal was limited by legislative enactment it increased considerably by reason of its scarcity. Again, from early in the year 1917 there was inaugurated Government control of the coal mines, which continued in operation until some time after the end of the war. The main objects to be secured by Government control of collieries—only justified by the exigencies of war—were the regulation of the working of the collieries, of the distribution of the coal, of the selling price of the coal, and of the prevention of unrest among the workmen.

A system of control of such a vast and complicated industry as the coal-mining industry of this country was only warranted by the abnormal circumstances which inaugurated it. It was a necessary evil, and, at best, and of necessity a policy of expedients. The sooner the management was unhampered and the representatives of the colliery owners and workmen could meet and negotiate as between themselves without the intervention of the Government, the better for all concerned. The Government control of the coal-mining industry did not result in the cessation of labour unrest. The number of disputes in the industry during the year 1919 was greatly in excess of that of any previous year. The demands of the miners, with which the Government was faced at the commencement of that year, were in respect of wages, demobilisation, and hours of work—a position not very dissimilar to that existing at the present time. The result was the setting up of the Sankey inquiry under the Coal Industry Commission Act of February 24, 1919. In October, 1920, took place the national strike of miners, and from then onwards there followed a period of depression.

The 1930 Act.—When the Socialist Party came into power, having promised the miners a substantial reduction in hours of work, the Government was called upon to implement their promise, but the impracticability of so doing, under the then existing conditions, was realised, so the Act of 1930 was passed, with the object of keeping up the price of coal by limitation of output, and in 1932 it was re-enacted for a period of 5 years, to make it operative until 1937. The effect of this Act was to impose restriction of output of coal at those collieries which, owing to natural conditions and modernity in point of age and equipment were best qualified to produce cheaply a plentiful supply of coal. In other words, the result of the Act was the sterilisation of the fit in order that the unfit might continue to exist, and it was well named in some quarters, "the dear coal Act." As I stated at the time: "This continuance is proposed in the face of the appalling shrinkage in the volume of exported coal last year. To bolster up prices by such artificial means as legislative enactment can only result in eventual disaster to the industry. The commercial greatness of our past was founded on a cheap and plentiful supply of coal and as a first-class power our future is equally dependent upon it." There is no doubt that this ill-conceived Act—the first statutory interference in the economics of the industry—to some extent, at least, was a contributory cause to restriction in extension and development at our modern and major coal mines.

Then, when the industry was, so to speak, "getting on its legs again," and improved conditions were beginning to become operative, came the second Great War, and shortly after its outbreak a system of semi-control was imposed upon the coal mines.

Wages and Absenteeism.—Wages—taking all classes together, men and boys working at the surface and underground—averaged over recent years as follows:—

Year	Average cash earnings per shift	Average wage of those employed at the coal face (men and boys)
	s. d.	s. d.
1914 ...	6 5½	
1932 ...	9 2	
1935 ...	9 3½	
1937 ...	10 8	
1938 ...	11 2½	
1939 ...	11 6·71	14 0·67
1940 ...	13 0·05	15 9·13
1941 ...	14 10·75	18 1·39
1942 ...	17 5·31	20 11·80
1943 ...	19 11·19	22 10·31
1944 ...	21 7·9	26 7·0
1945 ...	21 10	27 0

Since the year 1939, the year of the outbreak of war, to the year 1945 the wages cost per ton has increased by over 130 per cent.

Abstention from work on the part of the miners rose phenomenally—a feature which, as past experience shows, always follows a rise in earnings. Thus—taking surface and underground employees together:—

For the year	1939	the percentage was		6·4
,, ,, ,,	1940	,,	,,	8·3
,, ,, ,,	1941	,,	,,	9·0
,, ,, ,,	1942	,,	,,	10·4
,, ,, ,,	1943	,,	,,	12·4
,, ,, ,,	1944	,,	,,	13·6
,, ,, ,,	1945	,,	,,	16·3

and is still very high, but tending to decrease as the result, I believe, of active propaganda instituted to secure that end.

Our annual output of coal is now under 200,000,000 tons, our export under 9,000,000 tons. It is hard to see how, under a system of nationalisation, matters can be improved. The question as to how output could be improved may be considered under three heads, namely:—

(*a*) By a reduction in wages.
(*b*) By enforced attendance at work.
(*c*) By reorganisation of the mines.

Neither of the first two proposals would be practicable or possible of institution without engendering great strife in the industry; nor would longer hours of work. Nor would the latter if introduced lead to much enhancement of output. As from July, 1919, the time of the miners was fixed at 7 hours, plus one winding time, or about 7½ hours; later there was a return to the 7½ hours, plus one winding time. The hours worked at the face were about 6 hours and 15 minutes (less breaks for a meal). If the face is kept fully supplied with tubs, the time worked thereat in getting the coal to fill and despatch them in the allotted shift time is all that should be required of the miner; extension of the shift would only conduce to slackening of effort.

Organisation and Efficiency.—We turn, then, to the subject of organisation of the mines. One gathers from speeches made in Parliament and from what one reads in the daily Press, that the impression generally prevailing in the public mind

is that British coal mines are in point of mechanisation and organisation lagging behind those of the Continent of Europe and America, but if this is so, it is a mistaken view. As a matter of fact, our modern mines are fully abreast in point of technique and organisation of the best mining practice. Some of the older mines—and Britain possesses some of the oldest coal mines in the world—are naturally, in point of layout behind the more modern mines and in some respects are, therefore, incapable of being replanned. Where the Continent of Europe (especially Holland, where the coal mines date from 1919) and U.S.A. have the advantage over us is that their collieries are in general much more modern.

Some years after the first World War, the *Daily News* sent a deputation of British miners' leaders to the Continent to study there the position in the principal coalfields. The mission consisted of Messrs. Frank Varley (M.P. Nottingham, and a Member of the Executive of the Miners' Federation of Great Britain), Aneurin Bevan (Miners' Agent, Tredegar, Mon), A. H. Gill (Miners' Agent, Eastern Valleys, Mon), and G. N. Jones (Miners' Agent, Ladybank, Tamworth). In an interesting report, published by the *Daily News*, the mission stated that, in their opinion, "the best British methods underground are unsurpassed," and, again, "Judging from the underground workings inspected by the mission, and accepting authoritative testimony that these were typical, we have no hesitation in saying that in the main the Continent can teach us little so far as methods of working in the best British mines are concerned. It must be assumed that the Continental managers have profited by their own long experience, but in some respects it appears to us that the best British methods are superior."

And the Samuel Commission (1926) reported: "It is not sufficient that the best of our mines should be, as we think they are, unsurpassed in efficiency by those of any other country in the world. It is necessary that all our mines should be brought as nearly as possible to the level of the best." And this was in process of being accomplished under the system of amalgamation, which was brought into force in 1937, and would soon have been effected as far as is possible.

Present Position.—The outlook at the present time is not at all bright. Speaking on the Coal Budget for 1946-47, beginning on May 1st, in the House of Commons on July 24, 1946, Mr. Shinwell said that from the mines they expected to get 177,000,000 tons; from opencast workings 8,500,000 tons, and about 400,000 tons from briquetting. Exports, including foreign bunkers, would reach only 8,200,000 tons. Indeed, a most disappointing result. The country was consuming more coal than it had ever done. Without considering coal for export and bunkering, it was estimated that our inland requirements would amount to 188,000,000 tons. Coal for gas works consumption, with 23,700,000 tons, was higher than it had ever been and 24 per cent higher than in 1938, the last pre-war year. As regards electricity the consumption was 26,300,000 tons, which was 2,300,000 tons higher than in 1945, and 76 per cent higher than in 1938—pointing to the great expansion of electricity supply in the country.

Depletion in man-power accounts, in large measure, for the diminution in production. In 1913, 1,110,884 persons were employed at the collieries. At the beginning of the present year (1946) there were 698,000. There were still a number serving in the forces. For some time the number has been round about 700,000 persons. Personally, I am of the opinion that the existing shortage of miners will be only temporary. There has been a considerable variation in this respect. Thus, whereas, in the year 1936, the comparable figure was 771,500, in 1938 it rose to 802,100. The Samuel Commission, it will be remembered, took a long view on this question, and came to the conclusion that it was important that the industry should not unnecessarily recruit labour from outside, for in their opinion, "if, as is possible, in future, the growth of opportunities for employment in coal mining is not going to be so rapid, the difficulty of finding employment even for the children of those already in the industry will become very serious."

Such, briefly—very briefly—is an account of the present state of the great coal-mining industry of our country and of the factors and agencies which have conduced to bring about its present depressed state; which brings us to the consideration of the subject of nationalisation.

(To be continued)

Labour in 1946

By GERTRUDE WILLIAMS*

No. II—*(Continued from page 8, January 3rd)*

Size of Unions

ONE of the most difficult jobs for any institution with as long a history as Trade Unionism is to prevent its arteries from hardening. The increase in the size of the chief unions no doubt contributes greatly to their negotiating power but, at the same time, it makes the two-way traffic between leaders and rank and file more difficult to maintain. It is significant that the most serious disputes of the last year have been due more to the dissatisfaction of minority groups inside the unions with their own leadership than to serious disagreement with their employers. The unions have an immensely important part to play in the coming years, not merely because there is a Labour Government in power, but because of the general recognition that the workers have a right to an increasing share in the formulation of economic policy. If they are to play this part adequately, they will have to develop a wider outlook and a greater sense of responsibility of the repercussions of union policy on the welfare of the community as a whole. But perhaps their most pressing task—and one that is closely related to their wider responsibilities—is a domestic one; in many unions much more care is needed that the policies of those at the top are understood by those lower down. The unions have developed principally as defensive and aggressive organisations in a world in which the interests of their members were continually threatened by unemployment and by changing techniques which replaced traditional skills. In the new era of full employment and manpower shortage on which we are now entering, our future welfare will depend to a marked degree on the speed with which the policy and tactics suitable to the past can be adapted to a changed situation.

Unions and Production

That this responsibility is recognised in principle is indicated by the remarkable change in temper during the year that has just ended. Two circumstances may be singled out in illustration. The first was the speech of the retiring President of the Trades Union Congress (Mr. Charles Dukes), who urged on his hearers the importance of a great and rapid rise in productivity if the higher standards of living that were dreamed of were to become a reality. The second was the emphasis laid on the same topic in the King's Speech at the opening of Parliament. It is safe to say that it is quite impossible to think of either of these speeches being delivered in the couple of decades prior to the war. Throughout the whole of the inter-war period the general pre-occupation was with the problem of poverty and the inequality in the distribution of wealth. So much so that there was a widespread conviction that our production problems were solved, that we had moved into an Age of Plenty, and that all that remained to do was to ensure that each member of the community enjoyed a fair share of the bounty. We have had a rude awakening. Seven years of austerity, with little prospect of any immediate relief, have opened our eyes to the clear realisation that we still inhabit a world of shortages, made narrower by the exigencies of war, but not created by them.

This does not, of course, make it any the less essential to establish a greater degree of justice in distributing what we have got. Rather the contrary; for if there is one lesson that we have learned during the war, it is that it is much easier to forgive inequality in a world of plenty than in one of scarcity. Nor does it make us any the less anxious to build a social scaffolding to protect the individual from the dangers that threaten him from want. The National Insurance Act, the Family Allowances Act, the Industrial Injuries Act, all stand as witnesses to the earnestness of the modern wish for security and the insistence on some collective provision to ensure it. But, although all these were either passed or came into force during the last year, they represent the climax of activities that were the dominant interest of the preceding period. The fact that has gradually come to take the forefront of the stage is the realisation that no amount of legislative enactment to protect the standard of living of the population can be effective unless the wealth to be distributed is, in fact, being produced. Social security can ensure that what is produced is equitably distributed, but it is only by increased productivity that the quantity to be shared and, therefore, the standard of living of the mass of the community can be raised.

That the need for increased production has been so much stressed by labour leaders is, then, a matter of primary importance, but it will have little positive value unless their conviction is translated into action. And here the danger is the familiar one of the attempt to pursue at one and the same time two wholly irreconcilable aims. For a very long time the trade union movement has set itself to shorten the working

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day, and the 40-hour week has been one of its main objectives. Now that the war is over the lessening of tension combines with excessive fatigue to put increased leisure very high in the order of priorities of desirable targets. In one sense there is no reason why it should not occupy this place of honour; we live for other things than material wealth, and it is open to us to argue that we prefer more time to enjoy life, even if it means a less plentiful or less varied amount of goods with which to do so. What, however, is not permissible is to indulge in such day-dreaming as to imagine that we can have, as things are at present, both more leisure and more goods. So strong is the desire for the 40-hour week that there are some who insist that the increased output accruing from a less fatigued worker would in itself lead to a higher material standard of living; but this is wishful thinking. There are, it is true, many operations which can be speeded up by more intensive work during a shorter working week—the experiments of the Industrial Health Research Board have shown some remarkable results in this respect—but it would be fatal to assume that all productive work falls into this category. Even in manufacturing industries the possibilities are limited, for every extension of the use of automatic or semi-automatic machinery reduces the degree to which the human factor affects the speed of the operation; but what is more to the point is to recognise the immense area of production in which a reduction in working hours must, almost inevitably, result in reduction of work done—transport, distribution, commerce, management, &c., and it is this area which is increasing at the expense of the other. It will need, therefore, statesmanship of the very highest quality if the leaders of the organised workers are to be successful in getting over the idea that a shorter working day cannot be obtained in the immediate future without a serious fall in material standards.

The problem of increasing productivity is not, of course, one that rests entirely or even primarily with the workers. It is rather on the shoulders of the managers and technicians that the chief responsibility lies for improving the efficiency of production and, unfortunately, there are still a very large number of these—perhaps even a majority—who have failed to realise the need for hard thinking, initiative and resourcefulness. If, in what is said here, the emphasis is placed on the labour element in the job to be done, it is only because this article is concerned with a review of labour developments and not with the economic field as a whole.

Shortage of Manpower

The present acute shortage in manpower has brought home to us very forcibly that an economical allocation of our human resources is imperative if we are to produce as much as we can. During the war the need for increased output was so urgent that rapid adjustment of manpower to demands took precedence of the traditional belief in the right of a man to choose his own job, and labour was rationed in the same way as other scarce and valuable components of our economic life. But during the last year, most of these controls have been either abandoned or relaxed. There are still a few areas of the labour market in which some degree of restriction is maintained; for example, though a coal miner may leave his particular colliery, he may not seek employment outside the industry without permission; agricultural workers and builders are still controlled, and, for a short time still, Civil Servants may not leave their jobs. But, by and large, the choice of occupation has been freed from any legal restriction, though, of course, there are still those imposed by geographical, social, psychological and institutional factors. Once more, then, industries needing workers must attract them by whatever inducements it is in their power to offer; and we are beginning to realise the new problem with which the post-war world is faced. In the past, wage differentials were the principal lever for moving workers out of industries where they were redundant and into industries where they were needed. The movement was always fairly sluggish, for people do not readily change either their occupation or the locality of their homes, but if the changes in wages were sufficiently prolonged, the move eventually took place. Since the end of the first World War this adjustment of the labour force to changing demands of industry had been much slowed down both by the wide establishment of standard rates of wages and by the establishment of unemployment benefits and allowances. Before the first war there were fewer collective wage agreements—either voluntary or statutory—and even those that there were had had to take account of the danger that unemployed men might undercut the rates if they remained out of work for too long. Trade union negotiators were, therefore, more ready to allow a reduced demand for labour to mirror itself in falling wage rates. But the establishment of schemes of maintenance for the unemployed has largely removed the fear of undercutting; most trade unionists are too loyal to their organisations to undercut rates unless they are near starvation.

The provision for the unemployed through compulsory insurance is one of the greatest social reforms of the twentieth century, whose advantages far outweigh its disadvantages; nevertheless, it must be recognised that the rigidity in wages rates that it makes possible has slowed down the rate at which workers move from declining to expanding industries. The prevention of the fall in wages conceals the fact that further recruitment to the trade is not required, and unemployment benefit enables the unemployed man to postpone his decision to seek a new occupation. So that, even before the war, the problem of occupational distribution had become extremely serious.

In the present period the problem is particularly acute because the war has introduced many changes into relative wage rates. Industries which lost a good deal of their labour force have now to compete against those into which a larger supply of workers were encouraged to go, and are finding it extremely difficult to do so without offering wages that would prove uneconomic. For, though overtime and special wartime payments in the war industries are now no longer available, earnings are not much reduced on account of the increases in hourly rates that have been granted. Such industries as cotton and coal, whose expansion is essential to our economic health, find it impossible to attract the workers they require at wages they can afford to pay, partly because the work itself is less attractive than other avenues of employment that are open, and partly because their employment record is so bad that workers will not willingly put themselves again into trades which so often led to Heartbreak House. In other cases it is simply the unpleasantness of the work which is the main deterrent and the wide influence now exerted by this factor is something new in occupational distribution. Until recently the "unattractiveness" of a job played only a minor part in determining the wage rates attached to an occupation (except in the rather abstract analyses of some economic theorists!) for fear of unemployment prevented the majority of workers from putting too high a money value on their preferences in this respect. Nowadays, there is such a keen demand for labour that workers can pick and choose and there is no doubt that such industries as brick-making and laundries suffer from the unwillingness of men and women to do jobs where the physical conditions are less attractive than those of alternative occupations, even when the alternative work is less well paid. The wages offered by the industries that are considered less pleasant would have to be very much higher than those of their rivals to induce a much larger number of people to go into them. In many cases, for example, girls accept jobs which pay them as much as £1 a week less than they could get in laundries because they dislike the idea of dealing with soiled clothes or do not wish to spoil their complexions or hairdos by working in a hot and steamy atmosphere. It will be necessary for these relatively unattractive industries to speed up with the introduction of new methods which economise labour, and to reorganise themselves to be able to offer very much improved conditions if they are to get the supplies of labour they need.

Production per Man-Hour

Increased productivity depends, however, also on the amount of work done by a worker as well as on getting him into the right industry, and a good deal of evidence has been accumulated during the year to show that PMH (production per man-hour) is a matter of some concern. A generalisation on such a subject, which is one on which even particular estimates are liable to gross error, is not of great value, but those whose impressions are worthy of serious attention believe that productive efficiency has dropped dangerously. All sorts of reasons are suggested to account for this: people are tired and a little disheartened; austerity is still with us; there is slight incentive to work when there are so few desirable things on which to spend one's money, and P.A.Y.E. with its very exact correlation between more work, more pay and more tax, is the last straw. How much importance one should ascribe to each of these it is impossible to say, though it is certain that all of them have some influence. Perhaps it is necessary to add to these the effect of the labour shortage and the increasing extent to which the "guaranteed week" forms a clause in modern collective agreements, for it is a melancholy fact that probably some part of the reduction in effort is due to the removal of the fear of unemployment from millions whose lives have been shaped by it. For generations working people have lived under the shadow of this fear, and one need not be surprised that their responses have become, as the psychologists would say, conditioned to it; but it is no exaggeration to say that there is no problem more pressing and more urgent than that of finding a new and more honourable incentive to hard work. Already there are signs that enlightened managements recognise that new times call for new methods; the introduction of machinery for joint consultation with workers at all

levels is an attempt to emphasise the fact that workers are partners in the concern and share with the managers the responsibility for its efficiency. The deliberate fostering of such a spirit is as necessary to the industries that are coming under public control as to those that remain under private enterprise, for experience has shown that public ownership is not enough of itself to change the attitude of the worker unless it is accompanied by a new and higher status for the employees.

At the moment, the dangers of lowered efficiency are concealed by the "sellers market," but as the arrears are made up and world shortages become less acute, we shall have to be able to offer our goods at competitive prices. The developments of the next year or two will determine our place amongst the industrial nations of the world.

Naval Construction in 1946

By FRANCIS McMURTRIE, A.I.N.A.

No. II—(*Continued from page 6, January 3rd*)

British Navy (*continued*)

FOUR small craft of which mention should be made are the cable-laying vessels "Bullfinch," "Bullfrog," "Bullhead" and "St. Margaret's." These were built by Swan, Hunter and Wigham Richardson, Ltd., towards the close of the war, having been specially designed for anti-submarine work.

A new diving tender which has replaced the worn-out "Tedworth" is the "Deepwater," an ex-German vessel of recent construction.

Four oilers of the coastal type, to replace some of the thirty-year-old ships which have done such good service, are the "Birchol," "Cedarol," "Oakol" and "Teakol." All four were launched by Lobnitz and Co. during 1946. Their gross tonnage is 850, and they are propelled by triple-expansion engines of 1150 i.h.p.

Seven aviation store carriers, with a displacement of 990 tons, propulsion for which is supplied by a pair of two-stroke Crossley diesels of 480 b.h.p. each, were recently delivered. Four of these, the "Ripon," "Seafox," "Sea Gladiator" and "Sea Hurricane," were built by James Pollock, Sons and Co., Ltd., of Faversham; builders of the remaining three, named "Blackburn," "Roc" and "Walrus," are understood to be the Blyth Dry Docks and Shipbuilding Company, Ltd. Of similar hull form to the water carriers of the "Spa" type, but with a transom stern, from the Cockatoo yard at Sydney and the other from Thompson's Engineering and Pipe Company, Ltd., Williamstown, Victoria.

The last three frigates built for the R.A.N. are of a somewhat enlarged design, as compared with their predecessors, displacing 1544 tons and mounting the formidable armament, for their size, of eight 4in., three 40 mm Bofors and four 20 mm Oerlikon guns. With triple-expansion engines of 5500 i.h.p., they are reported to be able to maintain nearly 20 knots in service. Their names are "Condamine," "Murchison" and "Shoalhaven" respectively, and they were built by the New South Wales Government Engineering and Shipbuilding Undertaking; Evans, Deakin and Co., Ltd., Brisbane; and Walkers, Ltd., Maryborough.

An additional "Tribal" destroyer, the "Nootka," was completed for the Royal Canadian Navy last September, leaving only one, H.M.C.S. "Athabaskan," in hand. Otherwise, the only warship under construction for Canada is the light fleet carrier "Magnificent," launched by Harland and Wolff over two years ago. Apparently progress with this carrier has been slowed down, as in the case of the five sister ships to be completed for the Royal Navy.

United States Navy

Completion of the fifth battleship of the 45,000-ton "Iowa" class, the "Kentucky," now the three ships of the "New Mexico" class, all launched in 1917. One of them, the "Mississippi," has been taken in hand for conversion to a gunnery training ship, to replace the "Wyoming," dating from 1911. The other two units of the class are destined to be scrapped very shortly.

A light fleet aircraft carrier, the 14,500-ton "Saipan," was commissioned in July last. In most respects she is an enlarged and improved version of the "Independence" type. Her sister ship, the "Wright," should be in service very soon, as she was launched only two months after her. Armament of these ships comprises four 5in. dual-purpose guns, forty 40 mm Bofors and twenty-five 20 mm Oerlikons.

The projected fifth cruiser of the 17,000-ton "Des Moines" class has been cancelled; of the other four, only the "Des Moines" herself has so far been launched. An interesting feature of these ships is that the whole of the armament, comprising nine 8in, twelve 5in and sixty 40 mm guns, is fully automatic. Cartridge cases will replace wrapped charges, and shells will have an automatic fuse setting. Much of the extra displacement of these ships, as compared with the 13,700 tons of their immediate predecessors of similar design, seems likely to be absorbed by the rapid loading gear and extra magazine space involved in this interesting development; 6in and 3in guns of the cruisers "Roanoke" and "Worcester," still to be launched, are also of a new automatic model.

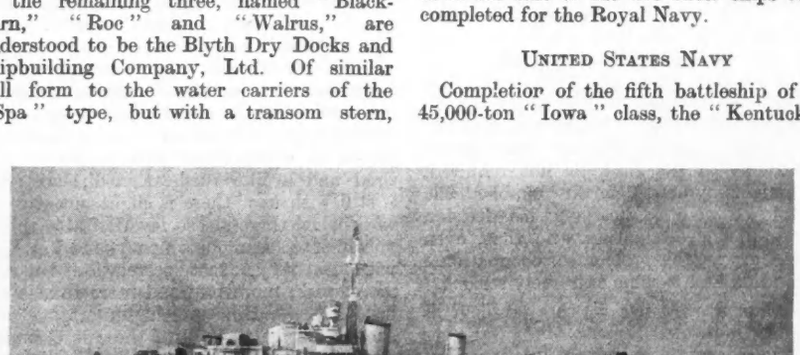
Cruisers passing into service during 1946 were the "Albany" and "Oregon City," of 13,700 tons; the "Huntington," "Galveston" and "Manchester," of 10,000 tons; the "Toledo," of 13,600 tons; and the "Juneau," "Spokane" and "Fresno," of 6000 tons. The outstanding feature of the three first-named is the reduction in the broadside silhouette effected by a single-funnel design with simplified superstructure, as seen in the accompanying illustration of the "Huntington."

Another prominent point that will be noticed in all recently built American warships is the radar equipment. This shows up very clearly in the close-up picture in our accompanying Supplement of the cruiser "Helena," much more so than in the corresponding view of H.M.S. "Howe."

In the case of the three 6000-ton cruisers mentioned above, "B" and "X" turrets, each containing a pair of 5in guns, have been installed a deck lower than in six earlier ships of the same class, doubtless with the object of improving their stability. For the same reason, eight torpedo tubes which are carried in the older ships have been omitted from the latest ones.

Evidently there was a tendency in the U.S. Navy, as in the Royal Navy, to overload ships in wartime with the object of increasing their offensive power to the utmost. Another instance of this is to be found in the formidable destroyers of the "Gearing" class, which mount six 5in guns in twin turrets (two forward and one aft). It is reported that the heavy weight thus borne on the forecastle has resulted in cracks developing in the hulls of some ships in the way of the forward turrets. Possibly this may be the reason why the construction of the last eleven units of the class was suspended in June, 1946.

There are conflicting reports about the 1570-ton submarines of the "Corsair" class, a number of which are now in service. Some accounts credit the most recent units with possessing sundry new equipment, similar to that which German ingenuity devised in the last batch of U-boats. Other statements



H.M. Australian Destroyer "Bataan"

they are to be employed in transporting aircraft to and from carriers.

Dominion Navies

In the Royal Australian Navy the third destroyer of the improved "Tribal" design, H.M.A.S. "Bataan," is now in service. No more of this type will be built; instead, two units of the "Battle" class are on order, one has been suspended, and will not be resumed till next summer. It is understood that her armament is to be altered radically by the inclusion of a number of rocket projectors, possibly foreshadowing what the capital ship of the future is to be. A similar delay is taking place in the case of the 27,500-ton "Hawaii," third and last of the battle-cruisers of the "Guam" class. How far the scheme of protection will be modified in the light of the lessons learned from the Bikini experiments remains to be seen.

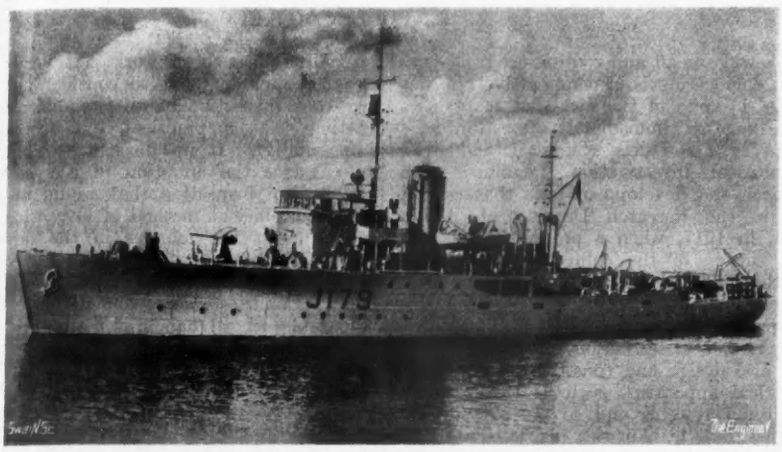
The oldest battleships in the U.S. Navy are

NOTE.—In the first article, page 6, names of builders of steam gunboats should have included R. and W. Hawthorn, Leslie and Co., Ltd., instead of Swan, Hunter and Wigham Richardson, Ltd.

contradict this, and assert that until exhaustive experiments have been carried through with the eight German prize submarines, nothing will be done in the way of adopting these devices. Colour is lent to this by the fact that construction of six of the "Corsair" type has been temporarily suspended.

The United States Navy Department has decided against the motor torpedo boat, war experience in the Pacific with these craft having proved disappointing. With the exception of four boats which will be retained purely for instructional purposes, all the hundreds of motor torpedo boats built during the war have been or will be sold. Circumstances of the Pacific operations were so widely different from those in European waters that it is improbable that these views are shared by the Royal Navy, notwithstanding the number of coastal craft offered for sale in this country recently.

An interesting ship launched last April was the U.S.S. "Burton Island," an ice-breaker of 5425 tons. She is of entirely welded construction, with a double hull. Propulsion is diesel-electric through three shafts, one forward and two aft. Total horsepower developed is 13,300, giving a speed of 16 knots. This vessel and a sister ship, the "Edisto," were built by the Western Pipe and Steel Company.



H.M. AUSTRALIAN CORVETTE "LAUNCESTON"

France

The work of reorganising and reconstructing the French Navy is proceeding slowly but steadily in the face of many difficulties, the chief obstacle being the financial one. The battleship "Jean Bart" is still some distance from completion, though the 15in guns originally made for her stillborn sisters, the "Clemenceau" and "Gascogne," are available to replace the ones missing from her turrets. She is to be given a new type of bridge and improved anti-aircraft armament, so will differ in some respects from the "Richelieu."

A useful addition to the seagoing fleet was the light fleet aircraft carrier "Colossus," which was lent to France last August by the Admiralty for a term of five years, in order that naval flying training may be conducted on up-to-date lines without delay. Otherwise the only French aircraft carrier is one of the escort type, the 8200-ton "Dixmude," as the old "Béarn" is now relegated to the status of aviation transport.

As redesigned, the 8000-ton cruiser "De Grasse," still to be launched, will mount nine 6in, twelve 3·9in, twenty-eight 40 mm and twelve 20 mm guns. Her Rateau-Bretagne turbines will develop 110,000 s.h.p., equal to a speed of 33·5 knots.

Eight German destroyers, allotted to the Royal Navy in the division of the ships which fell into Allied hands in 1945, have since been transferred to the French flag. Largest of these are the "Hoche," ex-"Z 25," and "Marceau," ex-"Z 31," the actual standard displacement of which is about 2400 tons. Having obtained this reinforcement of its depleted flotillas, the French Ministry of Marine decided to abandon the idea of resuming work on the shattered hull of the "Aventurier."

Of two captured U-boats taken over from the Royal Navy for experimental purposes, one, the 233-ton "U 2326," was lost last month, leaving in hand the 1600-ton "U 2518." Three of the four new submarines of the "Creole" class were launched during 1946.

Italy

Under the terms of the proposed Peace Treaty, the Italian Navy is to lose over 50 per cent of its surviving ships, including all submarines. There will be left two old battleships, four cruisers, four destroyers, sixteen large torpedo boats, twenty corvettes and an assortment of auxiliaries. Some British trawlers and motor minesweepers are also under the Italian flag, but whether they will have to be returned to this country when mine clearance is complete has not been announced.

Russia

Whether the 35,000-ton battleship laid down at Leningrad in 1939 was as badly damaged as reported during the war is uncertain. Another story is that she was actually launched in 1945, but this sounds highly improbable, as the material for her construction has to be supplied almost entirely from Soviet resources. According to the latest information, this ship is to be named "Sovietski Soyuz."

The ex-German cruiser "Nürnberg" has been renamed "Makaroff," after the admiral who lost his life when his flagship was mined outside Port Arthur in 1904. Other prizes from Germany include half a dozen destroyers, two large torpedo boats and some hundreds of other vessels, such as minesweepers, patrol craft and auxiliaries. Nine U-boats were taken over for experimental purposes, irrespective of any that may have been found intact in Baltic ports occupied by the Russian forces.

Sweden

Late in November the new cruiser "Tre Kronor," of 7400 tons, was commissioned for trials. For her size she is a very formidable-looking ship, armed with seven powerful 6in guns of a new model for which long range and great accuracy are claimed. A sister ship, the "Göta Lejon," should be ready some time this year.

Two new destroyers of 1800 tons, the "Oland" and "Uppland," have both been launched. According to an official sketch, recently published, they will mount eight 4·7in guns in twin turrets as their main armament.

Norway

Four British destroyers of the "C" type hoisted the Norwegian flag last year, and were renamed "Bergen," "Oslo," "Trondheim" and "Stavanger." Other acquisitions from the same source are the minesweepers "Bangor" and "Blackpool," now named "Glomma" and "Tana" respectively; three corvettes, renamed "Andenes," "Nordkyn," and "Söröy"; and three submarines of the "V" type, now the "Uthaug," "Utstein" and "Utvaer." Ten motor torpedo boats and two motor minesweepers were also purchased.

Netherlands

Though the proposal to acquire a cruiser from the British Navy fell through, the Netherlands fleet has been strengthened by the addition of the escort carrier "Karel Doorman" (ex-H.M.S. "Nairana"), and eight fleet minesweepers, built in Australia.

Work has been resumed on the hulls of the cruisers "Eendracht" and "Zeven Provincien," laid down in 1939. The latter ship was launched in December, 1944, but the other has still to take the water. Extensive alterations have been made to the original plans, but it is doubtful whether the proposed displacement of 8350 tons will be much increased. Respective builders of the two

U.S. CRUISER "HUNTINGTON"

ships are the Rotterdam Dry Dock Company and the Wilton-Fijenoord concern.

Belgium

Two fishery protection vessels which were seized by the Germans, the "Artevelde" and "Zinnia," have been recovered and are again under the Belgian flag. In view of the age of the latter (she was built in 1915 for the Royal Navy) it is proposed to acquire a British frigate of the "Loch" class to replace her for seagoing duties.

Denmark

Two destroyers of 710 tons laid down in 1939 and launched in 1942 are to be completed during 1947. They have been named "Hvitfeldt" and "Willemoes." Six torpedo boats, of 329 tons, are also completing, while the sea training of the navy, neglected for so many years, is being carried on in two ex-British frigates, the "Holger Danske" and "Niels Ebbesen." Two submarines, a corvette and eight motor minesweepers have also been obtained from the Royal Navy.

Greece

In the Royal Hellenic Navy there are now ten destroyers of British construction, two of which—both ships of the "Hunt" type—were acquired last year. There are also six submarines, four corvettes, eight motor minesweepers and seventeen motor launches, all British-built.

Turkey

Additions to the Turkish fleet in 1946 included the destroyer "Gayret," ex-H.M.S "Oribi," which was ceded to Turkey in lieu of the original ship of that name, lent to this country during the war and so badly damaged as to be unserviceable. There were also five fleet minesweepers of the Australian "Bathurst" type and a number of smaller craft, such as motor torpedo boats, motor launches, &c.

Poland

So far as can be ascertained, the only ships the Polish Government has yet been given by the Soviet Navy are nine wooden minesweepers of 130 tons, two motor torpedo boats and a dozen 40-ton patrol launches.

Portugal

Beyond acquiring the British minesweeper "Caraquet," which has been re-equipped as a surveying vessel and named "Almirante Lacerda," Portugal made no notable addition to her navy last year. The five destroyers of the "Vouga" class, built over ten years ago, are to be refitted and modernised on the Clyde under a contract entered into with the firms of Yarrow and Co. and Vickers-Armstrongs, Ltd.

Argentina

A lead has been given to the resumption of naval activity in South America by the Argentine Republic, which has authorised the acquisition of an aircraft carrier, a cruiser, four destroyers, three submarines, ten patrol craft and a supply ship. Tenders are to be submitted this month.

Chile

Three frigates and three corvettes were purchased from the Royal Canadian Navy last year, together with two oilers, two transports and fourteen landing craft from the United States Navy. In addition, a thirty-five-year-old merchantman, the "Gundulic," abandoned as a total loss in Chilean waters, has been salved and refitted as a transport, renamed "Magallanes."

Other South American Navies

The Dominican Republic has bought a frigate and corvette from Canada; Honduras has acquired a frigate from the same source, and Venezuela has obtained six corvettes, a seventh being wrecked on passage.

China

The Chinese Navy is renewing its strength in full measure. In addition to a corvette, the cruiser "Aurora" is to be purchased from the Royal Navy, with a destroyer of the "Hunt" type and a number of other vessels. From the United States Navy are coming four destroyer escorts, twenty-four minesweepers, thirty submarine chasers, six motor gunboats, two repair ships, three oilers, six lighthouse tenders, a surveying vessel and 193 landing craft of various types. Already a number of these have been delivered at Shanghai.

A Survey of Engineering Radiography

By V. E. PULLIN, C.B.E.

THE widespread and routine use of X-rays in engineering is of comparatively recent origin, in spite of the fact that many uses were suggested immediately after Röntgen's discovery. The first systematic industrial radiological investigation combined with research and development was that carried out in the Research Department, Woolwich, in 1917, when a preliminary lecture and survey of the subject was delivered by the writer to the members of the Ordnance Committee. This investigation was comprehensive in that it contemplated the design and construction of X-ray tubes and also design and construction of related electrical apparatus, such as transformers, rectifying systems and so on. A survey* carried out in America as late as 1938 disclosed the fact that only some five foundries out of 251 in the United States were using radiography as a concomitant of manufacturing processes. A few were also using the method as an acceptance test.

One of the first routine processes where X-ray inspection was used in this country was in the inspection of stressed light alloy castings for aircraft and very soon this method of inspection was adopted as a routine method by the Aeronautical Inspection Department. Another authority who adopted this method of inspection in the early days was the Engineer-in-Chief of the Navy, who insisted upon the radiographic examination of all important ferrous castings. At a little later date, but, nevertheless, quite early in the development period, Dr. S. F. Dorey, of Lloyd's Register, adopted this method of inspection for all high-grade boiler welding done under the ægis of Lloyd's Register of Shipping.

Although very considerable progress had been made in the development of apparatus and technique in radiographic investigation by 1939, yet it was the second world war years that intensified development of this method and established it as a recognised and permanent factor in the development and testing of a large variety of engineering materials. In the early days of the war the use of X-rays for the inspection of light alloy aircraft castings was very intensively developed, and so successful was this method in assisting in the production of sound castings that it became possible for aircraft designers to adopt castings with confidence, whereas, hitherto, it had not been possible to consider their general use.

Light Alloy Castings for Aircraft

With the necessity for very much enhanced production of light alloy castings for aircraft, intensive calls were made on this new method of inspection, and it became a matter of very great difficulty and anxiety to provide not only the apparatus in the quantities in which it was required, but also to provide skilled operators in this highly specialised branch of work. It very soon became apparent that to consider the 100 per cent inspection of all Grade I aircraft castings was a practical and economical impossibility. It was necessary, therefore, to consider the adoption of a system of radiological inspection that would at once prove an efficient method of inspection and would assist the founder in the development of better castings. This problem was aggravated by the fact that while light alloy foundries were demanding X-ray apparatus on all hands, yet supplies were very limited and were also subject to urgent calls from the medical services. In this connection it is to be lamented that British manufacture of X-ray apparatus was very restricted and consequently it was necessary to rely very largely on the importation of foreign apparatus. Very many inspection systems using X-rays were considered with a view to their adoption as an official A.I.D. procedure for light alloy castings. Finally, it was determined by the writer, who was at the time responsible for this particular inspection, that X-rays should be used as a method by which evidence could be adduced concerning the excellence of foundry technique and consistency in production. In pursuance of this idea, it was decided therefore, to require all designers of stressed castings to forward drawings of new patterns to the A.I.D. It was also requested that on these drawings the areas should be marked where ultimate high stress would be concentrated. On receipt of these drawings the A.I.D. classified the casting according to the difficulty that was to be anticipated in radiographing it. A casting that by its shape and size presented a difficult problem in radiography was placed in Category "A" and the drawing appropriately marked. The first off of a new pattern in Category "A" was despatched to the A.I.D. Test House, where a critical X-ray survey of the casting was worked out and a radiographic technique was evolved. The technique was so designed as to cover, as far as possible, the whole of the casting. This technique, which comprehended all relevant radiographic details, together with photographs showing the direction of all the shots, was recorded in a special technique folder. The folder was duplicated, one copy being retained by the A.I.D. Headquarters, and the second circulated to all the foundries in the country where that particular pattern of casting was being made. The radiographic inspection of such castings was done in strict accordance with the approved official A.I.D. technique. In the course of production, where the quality of the casting improved, as was usually the case, it was competent for the A.I.D. Inspector concerned to reduce the number of X-ray shots, or alternatively, to reduce the percentage of castings examined by the full technique. It was always emphasised that this particular X-ray investigation

* Lester, Sanford and Mochel, *Journal* of the Institution of Electrical Engineers, Vol. 84, No. 509, May, 1939.

of castings was not to be regarded as a 100 per cent inspection method but rather as a critical and thorough check on the consistency of foundry production.

At the same time light alloy founders were encouraged to use X-ray methods as far as they possibly could as an adjunct to the development period of casting manufacture. This practice, which was eagerly welcomed by a large number of light alloy founders, unquestionably resulted in a tremendous improvement in the quality of the castings produced.

In cases where the designer's drawing showed that the casting would present no particular difficulty from a radiographic point of view, it was classified "C." These castings were not required to be forwarded to the Test House for the preparation of a technique, but the radiographic examination was left to the discretion of an A.I.D. approved radiological laboratory.

Foundries and the A.I.D.

It should be mentioned that all foundries and test houses installing X-ray equipment for the purpose of inspection under the ægis of the A.I.D. were required to submit themselves and their personnel to the A.I.D. authorities for official approval. The laboratory itself was investigated from the point of view of the suitability of apparatus and its installation from the point of view of safety. Personnel were required to attend at the A.I.D. Test House for the three days test, after which they were either approved or rejected as the case might be. Such laboratories were periodically inspected by A.I.D. experts in order that the quality of their work should be consistently maintained. Bearing in mind that during the war the training of X-ray operative personnel was of necessity short and that large numbers of individuals had to receive this training, it is a most creditable fact that firms did, in fact, maintain a very high standard of radiographic proficiency, a standard that improved throughout the war years and undoubtedly laid the foundation for a highly skilled branch of specialised scientific activity.

Some idea of the organisation involved in the A.I.D. radiological system may be gathered when it is remembered that some 50 commercial radiological laboratories were approved by the A.I.D. during the war and that in some of the larger foundries the production of light alloy castings was as much as 400,000 or 500,000 per month.

Interpretation of Radiographs

It will be appreciated that one of the chief difficulties met with in such an inspection method as has been outlined is the interpretation of the flaws shown by the radiographs in terms of mechanical significance. This difficulty was enhanced because radiographic inspection and the general appearance of radiographs were entirely strange to most of the Inspectors who had to shoulder responsibility for the soundness of castings. It had been laid down that under no circumstances was the actual radiographer to assess defects in terms of mechanical strength or safety. That was inevitably to be the responsibility of the Inspector. It was the function of the radiographer to interpret the radiograph to the Inspector in terms that described the origin of the shadows on the radiograph. He would, for example, say that such a shadow was caused by a blow-hole or by a crack or by porosity and he would also be required to say whereabouts in the casting the defect existed. On this information it was the business of the Inspector to decide whether the casting should be used or rejected.

It is obvious that there is no quick path to proficiency in this type of interpretation. Reliable skill in this art can only be gained by long experience and by experimental investigation. Castings had to be cut up and defective areas compared with radiographs in order that Inspectors might have a real and objective idea as to the significance of the radiographic shadows. Nevertheless, it is a remarkable thing that after a comparatively short time the Inspectors whose business it was to adjudicate on radiographic evidence became quite extraordinarily proficient.

It might not be out of place here to emphasise that radiographic interpretation in the engineering sphere must always fall into two divisions. The radiographer will interpret the shadows and it is for the technical Inspector or Overseer to interpret the defect in terms of mechanical significance. Another aspect of radiographic investigation which demanded considerable attention during the war was involved by the introduction from time to time of new alloys, many of which were subject to characteristic defects. It was, therefore, necessary to consider these new materials in terms of radiographic investigation and to modify radiological technique to suit each particular type of case. Further, there were very many instances where radiographic inspection was not appropriate either for reasons of efficiency or economy. In these cases it was often necessary to consider and recommend alternative methods of non-destructive test.

Meanwhile, X-rays were more and more extensively used in the investigation of steel castings and also in the development of new casting processes in other alloys. X-rays were also used extensively during the war for the inspection of complicated assemblies, such as fuses, where many hundreds of thousands were inspected every month as a matter of routine. This work demanded the design of special apparatus, the evolution of complicated techniques in order to deal efficiently with large quantities, and the intensive training of personnel.

In the foregoing remarks, emphasis has been laid on the use of X-rays in the aircraft industry under the control of the Ministry of Aircraft Production, but it is intended that this reference should merely serve as an example. On the other hand, X-ray inspection in other branches of engineering activity and for other branches of the fighting services was similarly intensive and valuable. It would be quite impossible here to recount all the branches of engineering and service activities where radiological inspection was not only of the greatest service, but was quickly found to be an indispensable adjunct to production.

Apparatus

Before the war, the highest powered X-ray equipment in general use in industrial radiology was of the order of 250 kV. It is true that in one or two places higher voltages had been used experimentally, for example in the Research Department, Woolwich, 300 kV were used in routine practice. In fact, in 1925, a 400-kV equipment was constructed in that department and was used experimentally for a very considerable time. Again, in 1929, an X-ray tube was constructed in the Research Department at Woolwich, which operated continuously at 390 kV and 20 milliamps, and a considerable amount of valuable experimental work was carried out with this apparatus. During the war, the G.E.C. of America supplied several X-ray sets, operating at 400 kV, which were invaluable in the examination of comparatively heavy steel castings. This company also put on the market an X-ray equipment of great flexibility in operation which was rated at one million volts. One of these equipments was installed in the Armament Research Department and was invaluable in special investigatory spheres. Towards the end of the war, a similar equipment was installed in the A.I.D. Test House at Harefield.

For the investigation of light alloy castings in general it is probable that comparatively low kilovoltages, that is of the order of 250, and some times 400, will meet all requirements. On the other hand, for the investigation of heavy steel castings, involving sections of 4in, 6in or 8in, there is no doubt that radiographic investigation in the future lies in the use of kilovoltages of the order of one million and upwards.

There is no doubt that radium or its emanation, radon, has proved of great value in the investigation of heavy steel structures and no doubt will continue to be employed to even greater extent in the future. At the same time, in the opinion of the writer, where it is possible to use X-rays generated at one or two million volts or even more, this method will have definite advantages in most cases over radiography carried out by the gamma rays of radium.

Modern X-ray apparatus is from a comparative point of view quite remarkably efficient. Modern design and construction have to a very great extent eliminated the bugbears inherent in early radiological practice. Apparatus is now electrically safe, and protection for personnel against stray radiation has also been incorporated in the equipment in a very efficient manner.

Equipment for Special Purposes

As the engineering and industrial use of X-rays extends, as it unquestionably will, it will be necessary for manufacturers to modify equipment for special purposes. The necessity will arise for powerful stationary equipment of, for example, one or two million volts, having maximum flexibility and adjustability in movement in order to give accuracy of alignment over a wide range of applications. Such installations will demand special and expert care in installation, not only to give efficient performance, but to ensure safety of operating conditions. On the other hand, mobile X-ray sets of moderately high power will be required for investigation of such structures that cannot be moved to a central testing laboratory. The design of such sets will present many difficult problems concerned with robust construction, rigidity combined with flexibility in mounting the X-ray tube, and special safety problems will also have to be catered for.

The extension of X-ray investigation into the shipbuilding industry, particularly now that welding is assuming such an important part in that sphere, will also demand specially designed X-ray equipment. Here it will be necessary so to arrange the equipment that it shall be capable of being used in confined spaces. Also special X-ray tube mountings to permit ease and accuracy of operation under awkward conditions will be necessary. It is gratifying to note that at least one firm of X-ray equipment manufacturers is catering with considerable success for this particular application.

The widespread use of plastics in the future opens up another field where unquestionably

X-ray investigation and inspection will be particularly useful. It does not require much imagination to foresee that complicated assemblies, such as those used in the electrical industry, will all be capable of inspection by X-rays. In this particular sphere it will not be necessary to use high-power radiography, but, nevertheless, this method of inspection will be a *sine qua non* as the use of these comparatively X-ray transparent materials increase. These uses will call for special design of apparatus and for special technique.

Personnel

The widespread use of X-rays in industry has opened up a new profession concerned with operational and experimental industrial radiography. It is a branch of scientific activity that demands a sound basic training in the elements of physics superimposed upon which will be the specialised knowledge required in any particular branch of industry where the X-ray method is to be used. During the war, candidates for this type of work received *ad hoc* training, which was of necessity unsystematised and far too short. But this particular profession has now achieved such a degree of stability and recognition that even now special courses of training have been designed and are attracting a large number of students. The Kodak School of Industrial and Engineering Radiography has done remarkable pioneer work in this direction. Special courses have been designed in various branches of engineering radiography. Students undergo a theoretical training to a rigid and systematic syllabus, and they are also given instruction in the practical applications of radiography covered by the particular course. Such courses are already being held, covering the radiography of castings, the radiography of high-pressure boiler welds, and further courses concerned with the radiography of shipbuilding construction and other special applications are contemplated. Examinations are held at the end of each course, by which the ability of the student is assessed. One of the great advantages of these courses in radiography is that uniformity of practice is gradually being achieved.

One very striking illustration of the growing recognition and importance of radiography in engineering practice is inherent in the fact that quite a large number of the big ferrous and non-ferrous foundries have installed, or are installing, X-ray equipments. Many of the big engineering firms are also using the method both in development and inspection. Similarly many of the big shipbuilding yards are also providing themselves with X-ray laboratories. In the case of the large boiler-making firms, of course, the use of X-rays has been for some considerable time an established part of their practice.

Apart from the fact that the Government Departments are insisting upon X-ray investigation for very much of the work controlled by them, one of the chief organisations actively to encourage the use of this particular method of inspection is Lloyd's Register of Shipping. For many years now it has been the practice of Lloyd's Register to insist upon rigorous X-ray inspection of all Grade I pressure vessel welding and it is possible that in the future this important organisation may extend their radiological requirements to ship construction and special engineering structures.

Aircraft components because of their lightness will always lend themselves particularly to X-ray investigation, and there is no doubt that a very big sphere of radiographic activity will manifest itself as aircraft design and construction develops. It is impossible to forecast exactly how aircraft construction requirements will modify the future design of X-ray equipment. It is probable, however, that mobile X-ray equipment, designed for example to examine the internal construction of an aeroplane wing without dismantling it, would have considerable value. In this particular field of application, that is to say the investigatory, consultive or maintenance sphere, as opposed to the manufacturing side, it is improbable that very high voltages will be called for. On the other hand, compactness and lightness of design combined with extreme mobility, will be essential if X-rays are to become a useful and familiar tool in the hands of air maintenance personnel.

Aeronautics in 1946

No. II—(*Continued from page 12, January 3rd*)

Rotating Wing Aircraft

THE only British helicopter flown in public during the year was the Cierva Autogiro Company's "W.9" machine illustrated in the accompanying engraving. Rotating wing aircraft open up new fields of air transportation. No expensive landing grounds are necessary and they can fly in conditions of poor visibility. It is therefore with great interest that we note that several British firms are entering this branch of aircraft design and manufacture. Details of the new productions are few as yet. In the case of the "W.9" Cierva machine, it is known that a de Havilland "Gipsy Queen" air cooled engine with a maximum output of 200 b.h.p. is fitted, driving a single rotor, the reaction of which is balanced by thrust from a tail jet. The "W.9" is described as a research helicopter of metal construction; it has seating for two persons. The same company's weight-lifting project, known as the "W.11 Air Horse," is to have three rotors, each 46ft diameter. According to a model recently shown, the rotors on outriggers will be driven by shafts from the power unit within the "fuselage." A "Merlin" 1650 b.h.p. engine is to be used, with the coolant temperature controlled by a variable-pitch fan. A passenger version of this project will have 24 seats, whilst a freight version will have a designed payload of from three to four tons, whilst yet another version will be suitable for crop dusting and spraying. No further details are available.

Early in the year it was announced that the Fairey Aviation Company, Ltd., was designing a rotating wing aircraft at Hayes. Details are not yet available, but a model has been shown and in an accompanying engraving is reproduced a photograph of this model. The machine is known as the Fairey "Gyrodyne FB.-1" and is novel in that it is propelled in forward flight by a propeller and thereby retains advantages associated with the "Autogiro" rotating wing aircraft. A prototype is now under construction which will be used mainly for research purposes.

Finally, the Bristol Aeroplane Company announced its type 171 helicopter, of which we illustrate the model. Practically no details are available, except that it is to be of all-metal construction, with a single air-cooled radial engine of 450 b.h.p. It is of the single-rotor type, with an airscrew at the tail to counteract the main rotor torque. Accommodation will be for pilot and three passengers.

Cierva "W 9" Research Helicopter

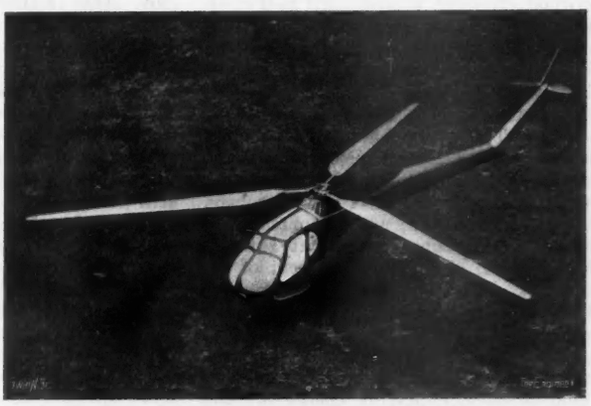
Gas-Turbine Aero-Engines

As already mentioned, development of the gas-turbine aero-engine, whether used in the pure jet, jet-propeller, or other combinations, was intense. Famous names—Rolls-Royce, de Havilland, Armstrong Siddeley, Bristol, Metropolitan-Vickers, Napier—are all associated with this important work. In this section we give a brief review of the latest engines announced during the year.

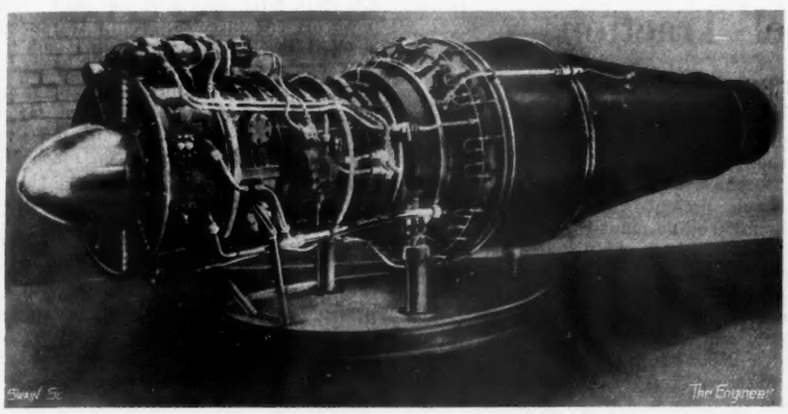
Pride of place is due to the Rolls-Royce "Nene" jet propulsion unit illustrated in one of our Supplement pages. This is the most powerful jet engine of this make of which any details are available. It follows closely the design of the "Derwent" engine, having a single-stage, double entry, centrifugal compressor, straight-flow combustion in nine chambers and a single-stage turbine driving the compressor. It is rated at 5000 lb static thrust at a rotating speed of

12,400 r.p.m. As we have already stated, this type of engine is used on the Vickers "10/44" jet fighter. It has also been fitted experimentally to a "Lancastrian" airliner, substituted for two of the "Merlin" engines normally fitted to that aircraft.

MODEL OF FAIREY "GYRODYNE" ROTATING-WING AIRCRAFT



MODEL OF BRISTOL "TYPE 171" HELICOPTER



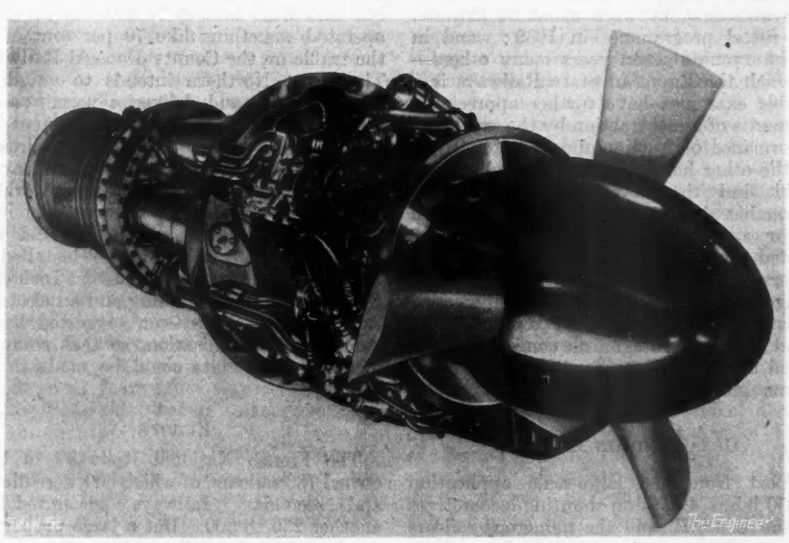
METROPOLITAN-VICKERS "F2/4" JET ENGINE

Another of the illustrations on a Supplement page shows the latest de Havilland production—the "Ghost" jet engine. Here again the design follows closely on that of the smaller "Goblin" unit. This engine gives 5000 lb static thrust, yet is only 3in larger in diameter than the "Goblin," which is rated at 3000 lb thrust. In the "Ghost" engine a single-sided centrifugal compressor delivers to ten straight-flow combustion chambers and a single-stage axial turbine. As with the "Goblin," there are but two main bearings. With this engine the rated thrust is developed at 10,000 r.p.m.

In a following section of this article, we mention that Metropolitan-Vickers "F2/4A" jet units are to be fitted to the "Saro" flying-boat fighter. This engine is also of the pure jet type, but has an axial flow compressor, with ten stages, an annular combustion chamber and a single-stage turbine. The flow is straight through, avoiding loss of efficiency in directing the air and gases round bends. The rated thrust is 3500 lb, and the overall diameter is but 37·9in. Other figures given for this engine are: Weight, 1750 lb; speed, 7700 r.p.m.; idling speed 2600 r.p.m., with thrust less than 250 lb; specific fuel consumption, 1·00 lb per hour per lb of thrust at the cruising rating of 3000 lb under ground level static thrust conditions. An illustration on this page indicates the small overall diameter. Work was also proceeding on development of this company's thrust-augmented engine, the "F.3" unit, which comprises a ducted-fan arrangement mounted on the "F.2" jet engine. Space precludes details of this equipment, but it may be mentioned that thrust is increased and fuel consumption reduced at the take-off rating, making the unit particularly suitable for installation in aircraft designed for speeds too high for propeller propulsion and too low for economic jet propulsion.

Another form of thrust-augmented engine, the "F.5," is in the form of an open fan augmentor, with similar advantages.

A full description of the Bristol "Theseus" gas-turbine propeller combination was given in our issue of September 20, 1946. This is the first gas-turbine unit to be announced by the Bristol Aeroplane Company, and has many interesting points. It is illustrated in one of our Supplement pages. It is rated at 1950 shaft horsepower, plus 500 lb of static thrust under sea-level conditions. One of the more interesting points is the heat exchanger, the first to be used on an aircraft power plant. This equipment weighs about 500 lb, but it is claimed that it will save its own weight in fuel after the first few hours' flying on long flights. For short journeys the heat exchanger can be omitted. With the heat exchanger, the fuel consumption is stated to be of the same order as that of a reciprocating engine of similar power. Another interesting departure in the "Theseus" is the use of a separate turbine drive for the propeller, there being no mechanical connection between the compressor and propeller turbines. The speeds of the two turbine wheels are maintained at a constant ratio by an ingenious mechanism controlling the pitch of the propeller blades. This separation of the propeller and compressor drives has advantages mainly in connection with control and ease of starting. With regard to the larger Bristol "Proteus" engine, the only



ARMSTRONG-SIDDELEY "MAMBA" GAS TURBINE PROPELLER ENGINE

information that may be given is that its power is of the order of 3500 h.p. Four coupled pairs of "Proteus" units are to be used on the second "Brabazon I" prototype.

The subject of another Supplement engraving in this issue is the Armstrong Siddeley "Python" gas-turbine propeller engine. This powerful unit is rated at 3670 shaft horsepower plus 1150 lb static thrust at sea level. The main characteristics are a fourteen-stage axial, reverse flow compressor, with a two-stage turbine compressor drive. Combustion is in eleven chambers, giving a straight flow, and the airscrew is driven from the compressor shaft through reduction gear. It is a development of the earlier "ASX" engine, with the turbine redesigned to give additional shaft horsepower. This extra power has been obtained by arranging for the turbine to expand the gases down to atmospheric pressure, thus leaving only a minimum energy in the exhaust system. As a wing-duct installation, the maximum diameter of this unit is 48in, and the net weight 2980 lb. The estimated installed weight, including propeller, is 3950 lb. Perhaps more remarkable is the same firm's "Mamba" gas-turbine propeller unit. This smaller engine, illustrated herewith, follows the "Python" in general design and provides 1000 shaft horsepower, plus 320 lb static thrust for an overall diameter of 27in and a weight of 750 lb. These figures are for sea-level take-off conditions and are roughly equivalent in take-off power to a reciprocating engine of 1120 b.h.p. The "Mamba" has a frontal area perhaps 30 per cent of that of such an engine and a weight of about 75 per cent of that of the reciprocating engine. The small diameter is a consequence largely of the use of an axial flow compressor. Flow is straight through the engine, the air intake being arranged immediately behind the propeller spinner. After compression, the air flows through six combustion chambers to an axial-flow turbine and thence to atmosphere. Nowhere in the engine is the general flow of air altered substantially from an axial direction.

(To be continued)

Report on Diesel Traction

By BRIAN REED

THE status of oil-engine traction on the world's railways is peculiar—even if not as extensive as its protagonists would wish. The large stocks of diesel railcars, multi-car trains and shunting locomotives owned by many European railways in 1939 have been greatly depleted—partly by complete destruction, and partly because financial, labour and material factors have resulted in over 50 per cent of the stock left being as yet unserviceable.

Some of the shortage of motive power generally has been made good by the acquisition of war department diesel locomotives to undertake shunting and light freight and mixed-train working; but this procedure has been followed on a far smaller scale than was anticipated during the war years.

Numerous railways throughout the world were initiating, or were about to initiate, new diesel programmes in 1939; and in the intervening seven years many others—of which the Egyptian State Railways is a notable example—have further appreciated the merits of diesel traction by the successful performance of wartime diesel locomotives. On the other hand, builders throughout the world find themselves unable to quote reasonable deliveries. The bottlenecks of labour and certain materials, and others created by currency restrictions, are the factors responsible for the poor progress being made in the application of oil-engined locomotives and railcars at a time when diesel traction protagonists confidently predicted a boom. Even so, the signs are not discouraging.

Great Britain and Eire

Apart from the large-scale application of 350 b.h.p 47/50-ton shunting locomotives on the L.M.S.R. and the numerous railcars on the G.W.R., little actual work has been done by the British group railways. The L.N.E.R. has a handful of 50-ton shunters with English Electric engines, and one or two on order that are to have Petter two-stroke engines. The G.W.R. has a similar English Electric locomotive in service, and another seven, plus two gas-turbine main line locomotives, on order. The Southern Railway's present diesel stock is limited to three 350 b.h.p. shunters, but in November, last, a new scheme for lines east of Portsmouth was announced which would mean the acquisition of approximately 200 diesel locomotives of 400 b.h.p. upwards; and recommendations were made that would involve 2500 b.h.p. diesel locomotives for the West of England line. Moreover, a couple of main line diesel locomotives are to be tried by the L.M.S.R., and the L.N.E.R. has had under review the purchase of up to fifty railcars of the A.E.C. type.

In Ireland useful progress had been made with diesel railcars before war began, principally on the Great Northern Railway and the Northern Counties Committee, but also with cars of 74/100 b.h.p., which operated something like 70 per cent of all the traffic on the County Donegal Railways. The Great Northern intends to go ahead when finances and deliveries permit; but the centre of interest for the moment has shifted south to Coreas Iompair Eireann, which a year or more ago announced ambitious intentions for future diesel working, and placed orders for locomotive power-transmission equipments in England and Switzerland which are to be installed in mechanical portions to be built at Inchicore. Even diesel-engine building and an electrical works in Eire have been suggested by an independent organisation, so that complete motive power units could be made in the country.

Europe

The French National Railways in 1939 owned 786 railcars, of which 600 were diesel; and secondary railways accounted for another 250 to 300. But a large proportion of this stock is still awaiting repair, and only trifling orders for new cars have been placed. Revised standard designs have been evolved for 300 b.h.p. and 600 b.h.p. railcars, and also for locomotives up to 3000 b.h.p., though activity during 1946 was confined to the introduction of the Baldwin 660 b.h.p. shunting and transfer locomotives (see THE ENGINEER, September 27, 1946), a heavier and more cumbersome machine than the French National Railways' own 635 b.h.p. locomotives of 1938-39. Other locomotives of this and rather greater outputs are in the initial stages of construction in France, principally with the Sulzer engine as the power unit.

A good deal of the Netherlands Railways' diesel stock has been returned from Germany, but not many of the three-car sets are in workable condition, and this probably applies also to any of the 1800 b.h.p. five-car sets completed. This organisation recently acquired a score of the Whitcomb-Buda war-surplus diesel locomotives that were given a top rating of 640 b.h.p. by the makers. In North Africa and the Middle East this was not a successful design, and probably the Dutch authorities have substantially de-rated the engines. The Belgian National Railways also are in the market for heavy diesel shunting locomotives, but do not appear to have reintroduced as yet many of the successful pre-war fast diesel train sets

Just as war began, the Danish State Railways were about to put into traffic a powerful new diesel car having two pressure-charged Frichs engines, totalling 800 b.h.p. This was a development of the earlier 500/550 b.h.p. trailer-hauling cars, and is to be the standard for new construction for main line working, saturation point for Lyntog units apparently having been reached.

Recent news from Norway is that the three-car "Snogtog," ordered in 1939 for the Oslo-Bergen service and ultimately for the Trondhjem and Bodo routes also, have been completed and set to work; but whether these are actually powered by the 650 b.h.p. pressure-charged Maybach engines originally specified is not known to the writer. Apart from these trains, the Norwegian State Railways have 50 to 60 railcars, about half of which are available for traffic; and also the 2000 b.h.p. main line locomotive delivered by Krupp, which is equipped with two M.A.N. engines and Krupp-Lvsholm hydraulic transmission. Most of the Swedish State Railways' pre-war railcar stock—about 150 vehicles in all—was petrol driven, and the diesel cars—from 75 b.h.p. to 640 b.h.p.—built from 1913 onwards, were spread over the private lines. These practices have been modified by the State taking over many private railways.

Further east, the Finnish State Railways have on order railcars up to 400/500 b.h.p., suited to trailer haulage, to supplement those cars of 90 b.h.p. to 240 b.h.p. used before the war which are still available. Intentions are to apply oil-engined units to more of the main line and important secondary traffic. From the U.S.S.R. come the usual grandiose potential schemes for extensive diesel operation, but the only authentic news was given on the radio last summer, *viz.*, that high-speed diesel trains were running from Moscow to the Black Sea and Caucasus. What the radio news did not say was that these trains were built by Ganz during the early war years for the Hungarian State Railways, and were commandeered by the Soviets and altered to 5ft gauge. Each train has two Ganz 12-cylinder V engines set to about 500 b.h.p. Other Hungarian construction of 1939–40 included trailer-hauling cars of 500 b.h.p.

No new diesel construction is under way in Spain at the moment, but good use is being made of existing stock, particularly the Renault 300 b.h.p. and Maybach-

engined 400 b.h.p. railcars on the Norte and M.Z.A. sections. Comprehensive plans for the construction of diesel shunting locomotives and express railcars and train sets were drawn up some time ago by Renfe (the national railway organisation), but their consummation depends on an improvement in the general trade position and the ability of Spanish works to make the whole of the equipment except for small, specialised components.

Africa

Cessation of the war brought quick large-scale orders for 15 diesel shunting locomotives of 350 b.h.p. and a dozen 1600 b.h.p. main line locomotives from the Egyptian State Railways, which already had over 20 Ganz railcars. These orders went to the English Electric Company, Ltd., and were followed in 1946 by a further order for 19 railcar sets of the same make. Diesel locomotives and railcars of Fiat manufacture were being operated successfully in North Africa, Eritrea, Ethiopia and Somaliland in 1939-40; and to solve water difficulties there was a long-term use of war diesels on the Mersa Matruh line. Powerful diesel units have always been visualised over the last decade for the long-projected Trans-Saharan Railway, and probably some locomotives of four-figure power now being built in the U.S.A. to the order of the French Government will be drafted to the first-opened section of this African line. Diesel locomotives up to 1300 b.h.p. and railcars up to 600 b.h.p. are used in Algeria and other parts of French Africa, including locomotives of 750 b.h.p. in Madagascar.

Elsewhere in Africa, diesel units have been applied to a surprisingly negligible extent. The Kenya and Uganda Railways have a handful of English-built railcars of 200/220 b.h.p. with pressure-charged Saurer engines; there are a few very light cars in Portuguese East Africa; a few light cars and locomotives in the Belgian Congo; less than half-a-dozen shunting and cotton-line locomotives in Sudan; one Ganz car in Rhodesia; three German-built shunting locomotives on the South African Railways; and a few industrial locomotives of 750 b.h.p. downwards in various colonies and countries. The 1938 orders for 320 b.h.p. and 480 b.h.p. Ganz type railcars and twin units for South Africa and Rhodesia have not been completed.

Asia

Progress in manufacturing technique and facilities in India during the war years seem likely to put a different complexion on the diesel traction position, in that mechanical portions, at least, are likely to be made indigenously in many future orders. Further, though railcars and multi-car trains made up much of the pre-war Indian diesel stock and pending programmes, a larger use of medium-power diesel locomotives is probable for light mixed service and of medium-weight and heavy-weight locomotives for shunting. America already has a footing in that field with the G.E.C. 380 b.h.p. locomotives on the North-Western Railway, and with war transport equipment. But in Ceylon, English Electric still holds sway, and the 400 b.h.p. trains in traffic are to be supplemented by another twenty-three diesel passenger-carrying vehicles and by shunting locomotives.

Towards the Orient the most encouraging sign is the English Electric order for 350 b.h.p. shunters for the Federated Malay States Railways, an organisation that, prior to the war, seemed as if it would not look at diesel traction. More diesel locomotives for the Thai (Siamese) State Railways were constructed by Sulzer during the war years, and they represent what is perhaps the soundest, yet most advanced diesel locomotive design, put on narrow gauge lines with severely limited axle loads.

One would think that in China a vast potential market would exist for diesel units, particularly if vegetable fuel oils were available, such as the soya bean oil that was used for traction units in Manchukuo before the war. But apparently rehabilitation needs are so urgent that nothing but steam locomotives may be expected for some time. American-built locomotives of the 40-ton class are being used to some extent in the Philippines, where, in 1939-40 an extensive programme of converting petrol railcars to diesel had been inaugurated.

Australasia

Diesel traction programmes involving expenditure on the £2,000,000 mark are under way, sanctioned, or pending by the various Australian railway organisations, and include 200 b.h.p. railcars with English Electric motive power and transmission equipment for Western Australia; bogie shunting locomotives with the same make of engine, but of 350 b.h.p., for the South Australian Railways; railcars of the Walker power-bogie type for the Victorian Government Railways; and the recent proposals in New South Wales which include various types of diesel vehicles. As yet, there is nothing authentic as to diesel locomotives for the Trans-Australian Railway, a Commonwealth line that probably needs diesel locomotives more than any other route in the continent, and made its first enquiry about them in 1913-14. New Zealand has been in the market for multi-car diesel trains, though the actual ordering has been very much delayed.

South America

The thoroughness with which Argentine railways have operated diesel locomotives, mobile power-houses, multi-car trains, railcars and railbuses, and the extraordinary wealth of information that has been embodied in the specifications and reports of the diesel traction commission of the British owned railways form a valuable reservoir from which British makers can draw when making up estimates and designs for most parts of the world. The contemplated programmes involve several million pounds and several hundred locomotives and railcars; and to this demand must be added that arising from the extensive Argentine State Railway's system which hitherto has confined its diesel stock to Ganz cars and trains of 240 b.h.p. to 640 b.h.p. The first enquiry arising from the British-owned railways' commission is for cars of the order of 400/500 b.h.p. for the Central Argentine Railway; but the State Railways have even proposed to build oil engines and mechanical portions, though some years must elapse before any schemes of this nature come to full fruition.

Experiences on the Central Uruguay Railway with Ganz railcars was not too happy, and these vehicles are now working on the Uruguay State Railways, which always owned them. But the results have not deterred the U.S.R. from inviting bids for further railcar deliveries, though no order has been placed. The M.A.N. 1100 b.h.p. triple-car train in Chile is reported to have proved successful, and possibly now has been joined by the second unit, which was held at the Swiss-Italian frontier during the war years, having just "missed the boat" at the time Italy entered the war. Since that time several American-built locomotives of 380 b.h.p. and 600 b.h.p. have been set to work in Chile, and the tendency seems to be towards the introduction of more of the same powers and makes, though some of the latest orders are to incorporate Sterling Viking engines.

Walker Brothers (Wigan), Ltd., still holds the lead in Peru, and has in hand power bogies and cars for Peruvian Corporation lines, though further orders may be expected from that Corporation for interesting diesel units for use on the Central Railway, which climbs 15,000ft in a hundred miles. Despite the early lead of British and European makers in Brazil during pre-war years, the big developments now beginning in that country have been met solely by American manufacturers, with double-bogie locomotives of 380 b.h.p., 600 b.h.p. and 1000 b.h.p., many of them of G.E.C. and Alco make. Larger powers are proposed for lines such as the Central of Brazil, to haul heavy freight trains, but a return is also being made to the construction of multi-car trains for fast inter-urban passenger services. As in Argentina, expropriation and exchange difficulties cloud the issue for British makers—but not for those in North America.

The National Railways of Colombia have placed orders in the U.S.A. for diesel railcars, after having acquired twenty-two of 250/275 b.h.p. during the war, and are desirous of ordering more. But recent reports stress the dissatisfaction felt in Colombia at the way the American makers have been handling orders placed, delivery being overdue and contrite hearts absent. In Trinidad, one of the successful Hunslet locomotives, of 275 b.h.p., was introduced during the war.

North America

Though many secondary lines in Mexico are suited to operation by diesel railcars, the National Railways have tackled first the substantial improvement in through passenger and freight services over the most difficult sections of the northern main line by the introduction of fifteen or sixteen Baldwin locomotives of 2000 b.h.p. The number of locomotives necessary for the services has been cut by about 50 per cent by the substitution of diesel for steam, and more heavy locomotives and multi-car sets are envisaged.

Of the immense progress made in diesel traction in the U.S.A. during the war and post-war years, little need be said here. The details are well known in Great Britain. American streamliners and diesel locomotives have a Press and propaganda value that does not stop at the Atlantic seaboard. As recently as Hogmanay the writer heard a woman from California declaiming in the lounge of a Rothesay Hotel: "And, oh, the streamliners! They go terrifyingly fast and they're polished like a needle! They have bright lamps: one shines upwards, and you wouldn't dream of driving over a crossing if you saw one of these sky-beams within the horizon!" And, after that, what attraction have prosaic details of over 4000 diesel locomotives of 300 b.h.p. to 8000 b.h.p.; more than 200 freight locomotives of 5400 b.h.p., introduced in four years; 80 m.p.h. schedules over start-to-stop distances of 15 miles; a million miles without general overhaul; and continuing annual mileages of 350,000 to 395,000?

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER, *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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THE REMUNERATION OF ENGINEERS

THE length and liveliness of the discussion on "The Remuneration of Engineers," which brightened our correspondence columns during the concluding weeks of last year, leave no doubt that there is a feeling amongst young and even middle-aged engineers that they are shabbily treated by employers and perhaps more particularly by municipal corporations and large public bodies. The discussion, it must be admitted, was rather one-sided. It was supported by several members of the Association of Scientific Workers, who are anxious to see engineers affiliated in a registered trade union, and it concerned itself rather with the "grievances" of engineers than with the causes of them. One would have liked to hear more from the other side. One would have liked to hear the employers' reasons for not paying more. If the scale of remuneration is generally too low, and we have no evidence so far that it is, then there must be some sound reason why it is not higher. We should have welcomed an exposition of those reasons by an employer or two and especially by a public body. It may be that the principle of the lowest tender is so engrained in the bosoms of municipal councillors that they are unable to free themselves from it even in such a delicate affair as the engagement of qualified engineers. We do not know, and it would be interesting and instructive to know; to hear the other side of the question.

If we neglect for the moment the thorny problem whether it is fitting or unfitting for professional engineers to be members of an avowed trade union, and pass over those parts of the correspondence that are in essence propaganda for the A.Sc.W., two points stand out clearly. The first is that the possession of a degree—the B.Sc. is selected—of itself is regarded as carrying a right to a good starting salary. That is one point debated in the discussion. The other is resentment against the practice of employers of inviting applicants for posts to state the salary expected. Now, a great deal can be said and a great deal has been said in support of both these points. We dare say that the balance is in favour of both. But it is only fair to look at the other side also. Take the question of the B.Sc. Let it be agreed that the possession of that degree does indicate that the owner has gone through a certain course of training and has profited by it so far that he was able to pass an examination. Let us go further and say that he has potentialities that a man without the degree might not have; the degree is, so to speak, an assurance that he has that potentiality. But unfortunately it cannot show that he is able to make use of that potentiality. This is, possibly, the snag. The fact is that holders of degrees are becoming as common as blackberries and the employer is not able to distinguish between those that are worth large starting salaries and those that are not, until he has tested them. The plea is that there ought to be a recognised minimum wage—it really comes to wage at this level—for a B.Sc. Probably that could be arranged without very great difficulty. But is it certain that it would be to the advantage of the profession and that it would raise it in its own estimation and in the eyes of the world? That it would assure the immediate future of young engineers may be agreed, but would it help their future and the future of those who display qualities above the ordinary? It is well known that minima tend to become maxima, that an employer gets rid of a man if he does not find him worth much more than the minimum and tries his luck with another. It is not—not always, at least—that he is unwilling to pay more, but that he wants the best value he can get for his money. That the establishment of a minimum which could only hold for a year or two at most would be worth the candle remains to be proved. On the other point we have selected, the question of stating the salary required, the grievance seems to be that it is a kind of inverted action, the applicants seeking to underbid each other secretly—as they would do were they tendering for a contract. Has it, in reality, a very bad effect? We may suppose that the applicant knows what he considers himself worth and it is for him to say so. If the salary were stated and he did not like it he would not apply for the post. If he does tender too high a figure and fails to get the job he is in just the same position. Looked at from the other side, it not infrequently happens that the employer does not know the market value of a vacancy and he uses this obvious means of finding out.

There is in affairs of this kind an ever-present danger that the grievances of a few will be exalted into a general grievance. No one decries more heartily than we do the insultingly low salaries that are sometimes advertised. We have protested against them in the past and shall do so again when occasion demands. They deserve the scorn of all self-respecting engineers. But we suggest that more is likely to be achieved by the education of the public on the value of engineers than by concerted pressure. If the status of engineering could be raised in the public mind, such impertinent proposals would not be made even by the most ignorant of town councillors. Some, however, may object that status cannot be raised without first raising salary. For those who think along such lines, membership of a trades union seems the only logical answer.

ROTARY WING AIRCRAFT

AT a recent meeting of the Helicopter Association of Great Britain, Group Captain Liptrot gave a comprehensive survey of the efforts made in many countries to develop the practicability of flight with rotating wings. Although it had long been an idea in men's minds, and many ingenious inventors had been at work thereon, it was not until the energy and genius of Juan de la Cierva came on the scene that a practical aircraft, the autogiro, was produced. An early model shown in flight at Farnborough a few years after the end of the first World War caused great astonishment, not only because there was no mechanical connection between the engine and the rotating wings, but because the sense of the wing rotation was the opposite of that which common sense, at that time, would have suggested The autogiro resembled the ordinary small aeroplane of the day, in that a tractor engine and airscrew were mounted in the nose of the fuselage, but the usual fixed wings, to provide the lift, were replaced by an overhead windmill, or rotor, consisting of three or four blades carried on a vertical shaft and rotating in a horizontal plane. It had the great merit that if when in flight the engine power was suddenly cut off, a steady parachute-like descent took place with the windmill auto-rotating until the ground was safely reached. The odd thing was that in that motion the angle of incidence of the blades was a positive one, which might have been expected to lead to a retarding drag sufficient to cause the rotation gradually to cease; whereas actual experience, even with the engine power entirely cut off, showed the contrary. The scientific reason for that was not long in appearing; but not only were the R.A.F. officers who observed the first demonstration at Farnborough surprised, but many engineers who were present were hardly less puzzled. It is a vitally useful phenomenon in rotary wing aircraft since it affords an automatic safety device when engine power fails. It depends, however, on the angle of blade incidence being small.

The autogiro requires some self-starter device for bringing the windmill up to speed, but once that has been done the forward motion of the aircraft as a whole suffices to keep the rotation going. The length of take-off run required is far shorter than that of a normal aeroplane, whilst its landing run can be almost negligible. It was said with truth that it could take off from, and land on, a tennis court. Like all rotary wing devices, it is incapable of being designed for efficient high speed operation, since the forward-moving wing tips have to move at a rate equal to the sum of the forward speed of the aircraft and the peripheral speed of the blades, so that the drag is bound to be greater than that of fixed wing types; moreover, difficult stability conditions attend any search for very high speeds, nor has it hitherto been

very efficient as a weight carrier. On the other hand, there are many duties, such as reconnaissance, sea rescue work, taxi work from cities to airports, or operation in difficult terrain, where the qualities of easy take-off from restricted areas and easy descent almost anywhere are of paramount importance. Actually a good number of autogiros were built in pre-war years, though the type never had time to become really popular; no doubt the personal drive behind it lost much through the unfortunate death of its inventor in a flying accident in a normal type of aircraft. Certainly it is true that, as Group Captain Liptrot pointed out, Cierva's autogiro was a major contribution to the development of all types of rotating wing aircraft. Some forms of autogiro became, indeed, true helicopters when at take-off the rotor was intentionally overspeeded, with the blades at a small angle of incidence, and that angle suddenly increased so that the craft leaped vertically from the ground; with the blade angles restored to the autorotative setting the craft could continue in flight as a normal autogiro. In still later models, such as Dr. Bennett's gyrodyne, this combination of qualities is, we understand, carried even further, apparently without the need for change of blade angle in flight, and autorotation is preserved in the event of power unit failure.

It once seemed that the basic problems of rotary wing flight had been met by Cierva and that practically everything that a helicopter could do had been achieved. One quality, however, was missing, and that was the capacity for hovering flight in still air. This feature has since become so highly rated that great energy has been applied to the endeavour to produce aircraft which shall be true helicopters, despite the drawback of having throughout the flight to drive the rotor by a lengthy mechanical transmission from the engine, and the even graver one that should the engine fail a crash-landing must result unless there is time enough during the fall to reduce the blade incidence to the autogiro figure, whether automatically or by the action of the pilot. The disadvantage of the long mechanical transmission could be avoided if the blades carried their own thrust-producing elements. An early attempt to do this in the Isacco heliogyre failed because the radial acceleration field produced by the rotation was so intense that in the little carburettor-engines mounted on each blade the free fuel level was nearer the vertical than the horizontal! It may be that with the coming into use of the turbine engine, with its propulsive jet, a more practicable lay-out will be found possible. But whether this be so or not, there can be no doubt of the growing popularity of the helicopter for the many services within its range. For crop dusting, for example, it is an almost ideal instrument, and illustrations have been published showing one of the Sikorsky helicopters leaving the roof of the Philadelphia Post Office carrying mail to the airport, which by that route was not 4½ minutes away instead of the usual 35 minutes by road. It is, however, an interesting speculation whether the quality of hovering may not, with the steady growth of engine power, become attainable at will with ordinary types of aircraft by "hanging on the propeller," or even by "sitting on the jet."

Obituary

WILLIAM SYDNEY EDWARDS.

LOCOMOTIVE engineers will learn with regret of the death, on Saturday, December 28th, 1946, after a long illness, of Mr. William Sydney Edwards, managing director of W. G. Bagnall, Ltd., of Castle Engine Works, Stafford, and joint managing director of Cowlishaw Walker Co., Ltd., railway engineers, of Biddulph, Stoke-on-Trent. Mr. Edwards died at his home, "Enville," Sandon Road, Stafford, at the age of sixty-four. He had been failing in health for some time, but he continued to attend to his business affairs until about a week before he died.

Mr. Edwards was a native of Hanley, and he received his early education at Hanley High School. In 1896 he was apprenticed to the firm of Kerr, Stuart and Co. and received his training under the late Mr. Hartley, who was a well-known engineer in North Staffordshire. In 1902 Mr. Edwards was appointed chief draughtsman at W. G. Bagnall, Ltd., a firm which has built locomotives in Stafford for over seventy-five years. Mr. Edwards later became the general manager of the company and in 1932 he was made managing director. For many years he was a prominent Staffordshire engineer and industrialist, but he found time to attend institution meetings in London and was a Vice-President of the Institution of Locomotive Engineers and a member of the Institution of Mechanical Engineers. Since 1938 Mr. Edwards has been President of the North Staffordshire Engineering Employers' Association, and he was Vice-President of the Birmingham, Wolverhampton and Stafford District Engineering and Allied Employers' Association. He was also a member of the Midland Regional Committee of the Engineering and Allied Employers' National Federation, and a member of the Council of that body. He was a member of the General Council of the North Staffordshire Chamber of Commerce, and was Chairman of the Stafford County and District Building Society. His death at a comparatively early age will be regretted by his many friends.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE LATE P. W. WILLANS

SIR,—I should be grateful for any information that can be given me by readers of your journal regarding my father, the late P. W. Willans. For some time past I have been urged to undertake the work of writing his life, and since coming out of the Navy I have had the good fortune to meet an old, if not the oldest, living pupil of my father, and he has promised to collaborate. I am, meantime, particularly anxious to obtain information relative to the period, *circa* 1874-1888, although information down to his death in May, 1892, will be most valuable.

Should there be among your readers any engineers who were employed at the Thames Ironworks, they might be able to tell me whether it was a fact that the pattern shop, or some shop, was, until the close of the firm, driven by a 3-cylinder launch engine. This was the first Willans engine ever built.

Information can be either sent to me at the address below, or if more convenient, to E. S. Ormsby, M.I.Mech.E., at 40, Grosvenor Gardens, London, S.W.1.

KYRLE W. WILLANS, M.I.Mech.E., M.J.I.E.

Shattrick, Broadway,
Ilminster, Somerset,
January 3, 1947.

"WHERE DO WE GO FROM HERE?"

SIR,—Mr. Rice's article, and your own leader, of December 27, 1946, should provoke an interesting discussion.

The idea of an unavoidable conversion of our people into a race of Robot machine operators is horrifying. Yet it is undeniable that matters have gone some way in that direction in many industries. This is, however, not of recent origin. It is indicated by Adam Smith in his chapters on Division of Labour, even in his time. Mr. Rice is right in his denunciation of the evils of this development—but is he right in seeking a sociological answer to a mechanical problem? We have all come in contact with the cases, in war production especially, in which a group of Robot operators were each able, on piece-work, to draw much higher wages than the skilled man, whose job was to keep the machines trued and tooled up, and in fact to provide the intelligence for the whole group. An absurd situation; but the common-sense remedy is to make the machines for these jobs fully automatic, let the skilled man control as many machines as he can, and dispense entirely with the human Robots. Against this, we have the Trade Union claim to restrict the worker to one machine; this claim will have to go. We have also the unfortunate fact that some workers have Robot brains, and will not take kindly to being offered different work, such as agriculture, land reclamation, road-making, or other jobs demanding both physical and mental effort; this is a matter of reforming our system of education. There is also the politician's claim of "a policy of full employment." But as no one has yet condescended to tell us what is meant by that phrase, it is difficult to discuss it. It appears, therefore, that this problem is to be solved by the engineer devising automatic machines for all mass-production jobs, the Trade Unions coming down to common sense, and the departments which now try to organise everything, putting the superfluous labour where it is really wanted, for work having a higher public purpose than a mere inflation of wage packets.

FRANK L. WATSON.

Lyndhurst, Hants.
January 3, 1947.

LOCOMOTIVE BOILER PRESSURE

SIR,—I agree with Mr. Graham that my statement that "no appreciable lightening of moving parts is possible" is misleading when taken from its context. The meaning of the complete statement is quite clearly that the reduction of cylinder size made possible by higher steam pressure does not of itself open up any possibility of appreciable lightening of moving parts.

It has always seemed obvious to me that moving parts should be as light as possible and, consequently, that advantages may be expected when motion that is heavier than it need have been is replaced by something lighter.

It also seems clear to me that if it is found

that a boiler for (say) 280 lb pressure can be made very little heavier than an existing one of the same size for (say) 180 lb, then the existing one was not so light as it might have been. If minimum **total** weight is really the aim, then low pressure is useful because it can save more weight in the boiler than it requires to be added elsewhere.

I am aware that the tendency is to adopt higher boiler pressures but I have a suspicion that what has been done in some cases because of necessity has been copied in others to keep in with a fashion.

W. A. TUPLIN.

Huddersfield, January 4, 1947.

REMUNERATION OF ENGINEERS

SIR,—The correspondence on this subject has elicited letters which have revealed varying attitudes towards work. It would appear that none of the writers has the viewpoint to which you refer in your leading article of December 27th, entitled "Money or the Common Good," which states: "Yet few men, as a group, are better contented with their lives. Money to engineers is, thus, far from everything. A satisfying job is deemed at least equally important."

Surely this is the attitude of any engineer worthy of the name, and if a man has not entered the profession because he felt that no other career was so attractive and afforded such scope for creative work, he is not an engineer at heart. Furthermore, if a job is not satisfying, a high salary will not make a man contented; still less a true engineer who, by his nature, will want to give his best to the job.

The correspondence revealed that a degree and/or membership of an institution is considered desirable because of the commercial value. There is not a breath of a suggestion that membership is regarded as an honour, as it should be, and for that reason desirable.

With regard to trade unions, membership, even if voluntary, is not regarded as an honour. If it becomes compulsory, generally, it will be considered an irksome and unjust condition of employment. Membership of any association implies support of and agreement with its policy and aims. The A.Sc.W., is affiliated to the T.U.C., the objects of which are avowedly political; hence, apart from a man's attitude to trade unions as such, membership of any trade union may result in supporting political activities with which there is no agreement.

Judging by their activities, the main object of unions is to secure for their members ever-increasing wages for ever-decreasing output in the form of a shorter week. There is an entire absence of stress upon the moral obligations towards employers, that a fair day's work should be given for a fair day's pay. It is to be hoped that there is indeed a "fundamental unity of management and labour," since the prosperity of the country is so obviously "bound up with their combination," to quote again from your leading article of December 27th.

E. B. PARKER.

Little Sutton, January 4th.

AGRICULTURE AND THE ENGINEER

SIR,—The article "Mechanical Engineering and Agriculture," by S. J. Wright, appearing in your journal, arouses interest in this important subject. There are, however, grave difficulties to be overcome before this field can be opened up to provide careers for young engineers.

Mechanical soil preparation and mechanical harvesting is but one aspect of agricultural farming crying for technical development. Proper processing of gathered harvests is even more urgent and ranks in importance with effective soil fertilisation and seed germination.

Possibly as the result of being an engineer son of a farmer, it has long been my ambition some day to marry methods born of engineering science to the agricultural and horticultural processes of farming.

The gravest obstacle is power. Copious supplies of cheap power made the industrial revolution possible, but the farmer was not able economically to draw from this fountain head to an extent comparable to that of other industries.

In recent years the grid scheme has made electrical power available to many farms, but it is too costly for most processing work. Coal also is costly, and its transport to site often presents difficulties. At the moment any appreciable coal requirement of this "oldest and most important of our industries" is not likely to be sought after as a prospective market by a harassed Ministry! Oil, although easier to handle and to control during process usage, suffers from similar disadvantages.

Before any worthwhile progress can be achieved it seems to me that the Central Electricity Board, or some other authority appointed for the purpose, will have to make power available cheaply to the farmer. Such usages as soil heating, sterilisation, grain and silage drying could assist generating stations to obtain improvement in load and diversity factors. It should be possible for loads taken at other than peak hours to be charged at rates comparable with the domestic tariff rates of the great cities. (A time-controlled meter charging the energy at different rates according to the time of day, would be an effective safeguard against power being used at peak load hours.)

Conditioning, sorting, cleaning and protective storage are all matters of deep concern to the farmer, and each year the present inefficient traditional methods cost him (and the nation) much money.

The real approach to the problem of bringing technical achievement in farming into line with other industries lies in making cheap power available. What a paradise for the process engineer agricultural farming could become, provided he took the trouble first to learn something of farming!

E. H. BROADFOOT.

Broadway, Worcs, January 1st.

The Town and Country Planning Bill

THE text of the Town and Country Planning Bill, 1947, was published on Wednesday, January 8th, and on the same day an Explanatory Memorandum was issued by H.M. Stationery Office (price 4d.) in the form of a White Paper. The main objects of the Bill are to set up a new planning system to meet present-day requirements; to produce a comprehensive solution of the problem of development values in land and thereby to remove one of the main obstacles to good planning; and to provide Exchequer grants to assist local authorities in the purchase and clearing of land for the execution of plans.

With regard to the new planning system, the Minister of Town and Country Planning has explained that the Bill is intended to make practical such projects as the reconstruction and redevelopment of old towns; the preservation of green belts; the provision of open spaces in overcrowded areas; and the allocation of land for new houses, factories and similar establishments as exemplified in the Abercrombie Plan for London and development plans for other cities. The explanatory memorandum points out that the object of town and country planning is to secure that all the land in the country is put to the use which is best from the point of view of the community, and planning operates to achieve this end by controlling changes in the use of land, by securing that development of the right kind takes place, and by eliminating wrong uses.

The Bill requires local planning authorities, within three years, to make a survey of their areas and prepare development plans showing how they propose that the land in their areas should be used, and also designating the land likely to be wanted for various purposes within a ten-year period. In preparing a plan for a county, the county council is obliged to consult the councils of county districts. The plans are to be submitted to the Minister for approval, and he is empowered to give directions to planning authorities on the way in which their functions are to be performed. Provision is made for a review of the plans at least every five years, and local planning authorities can at any time submit proposals for alterations or additions to them. If, however, a local planning authority fails to make or amend a plan, the Minister can do it himself or authorise another local planning authority to do it.

Full powers are given by the Bill for the public purchase of land required for the carrying out of a plan, and provision is made for an Exchequer grant to local authorities in respect of loss on redevelopment operations; compulsory purchase, where the value of the land bought is reduced by putting it to a less profitable use; and payments to a landowner if the value of his land is reduced below existing use value. All purchases of land for public use—whether by Government Departments, local authorities or statutory undertakings—will be at existing use value, the 1939 standard being retained. The effect is that the value of land in the market will in future be reduced broadly to the value attributable to its existing use, and landowners thus lose their development values.

The Minister of Town and Country Planning has commented that the Bill substantially implements the recommendations of the Uthwatt Committee. It does not nationalise the land, but it deprives landowners of the right to build on their land unless the building is in accordance with proper planning requirements. It also creates a right to impose a development charge if permission to build is granted, thereby depriving the landowner of future "unearned increment" in land values. The Government takes the view that owners who lose development value as a result of the passing of the Bill are not on that account entitled as of right to compensation. It recognises, however, that if no payments were made, hardship would be caused in many cases, and it has decided that a capital sum should be made available out of which payments may be made to landowners. The Bill fixes this sum at £300,000,000 to cover England, Wales and Scotland. The method of distribution will be decided later on by the Treasury, subject to affirmative resolution of both Houses of Parliament.

The Bill, it should be stated, distinguishes two elements in the value of land: first, its value for the purpose for which it is being used, *e.g.*, agricultural, houses or shops, which is regarded as its "existing use" value; and, secondly, its value for a potentially more profitable use, *e.g.*, development of agricultural land as a building estate or replacement of houses by shops and other buildings, which is regarded as its "development" value.

Literature

BOOKS RECEIVED

Electric Motors and Generators Illustrated. London: Odhams Press, Ltd., 24, Henrietta Street, Covent Garden, W.C.2. Price 9s. 6d.

Factory Construction. By J. V. Brittain. Manchester: Emmott and Co., Ltd., 31, King Street West, Manchester, 3. Price 3s.

Controlled Atmospheres for the Heat Treatment of Metals. By Ivor Jenkins. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 50s.

The Hydro-Electric Power Commission of Ontario. Thirty-eighth Report. Canada: The Hydro-Electric Power Commission, 620, University Avenue, Toronto, 2, Ontario.

Geometry of Engineering Drawing. Third edition. By George J. Hood. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 14s.

Civil Engineering in 1946

No. II—(*Continued from page 29, January 3rd*)

London Regional Planning

NATURALLY, prevailing conditions made it impossible in the past year to make any definite start on putting into effect the proposals of Sir Patrick Abercrombie's 1944 Greater London Plan. However, an Advisory Committee, established at the request of the Minister of Town and Country Planning, reported to the Minister in July, 1946. The committee was set up to co-ordinate the examination of the 1944 plan for the outer area of the greater London region, and to arrive at an agreed outline plan for submission to the Minister, to serve as a directive to planning authorities within the area affected. Later in the year the Report of the Advisory Committee was published, together with the report of its Technical Sub-Committee. In general, the Advisory Committee was in favour of the main outlines of the Abercrombie plan, but proposed certain amendments, felt to be necessary either as improvements on the original plan or because of changing circumstances such as recent fluctuations in population. This review is not the place for discussing the details of the report, but its publication is welcomed as a sign that such preparations as can be made for an orderly and planned development of the London area are not being overlooked.

Another event which was of considerable interest was the publication of the Report to the Minister of Transport of the Railway (London Plan) Committee, dealing with the technical and operational aspects of the County of London Plan, relating to the main line and surburban railway systems, both on the surface and underground. One of the major recommendations in the report is that all Southern Railway suburban services now terminating at London Bridge, Charing Cross, Cannon Street, and Holborn Viaduct should be put underground by the building of new lines in deep-level tunnels. Other projected railways, providing cross London services, would bring the total length of new lines in tunnel to over 100 route miles. It is estimated that the scheme would cost about £230 million. An illustrated summary of the scheme was published in our issue of May 10, 1946.

LONDON AIRPORT, HEATHROW

London Airport, Heathrow

Heathrow Airport, or London Airport, as it is now termed, was officially handed over, in somewhat incomplete state, on January 1, 1946, by the Air Ministry to the Ministry of Civil Aviation, to be developed as the main terminal airport for London. Since then work has continuously gone forward in extending runways and providing temporary accommodation, while, at the same time, full air services were maintained without interruption by the engineering works in progress. We reproduce, herewith, a recent aerial view of the airport, which is 14 miles from the centre of London and lies between the Bath and Staines roads. Construction of the airport began in May, 1944, and since that date some £3,000,000 has been spent. Many engineering problems were overcome in draining and levelling the site, which included about 70 acres of ponds and gravel workings. At present the airport has three runways of 3000, 2000 and 2000 yards, with a perimeter track, partly completed, of 8330 yards, connecting the ends of the runways. The width of the runways is 100 yards and that of the perimeter track about 33 yards. On the main runways the concrete is 12in thick. However, the work so far done is but a small proportion of that planned. Already a further £6,500,000 has been authorised, and it is expected that the ultimate cost, excluding that of the main terminal buildings, will be at least £20,000,000. The new works planned include the extension of the airport to the north of the Bath road, necessitating a diversion of that road and demolition of several villages. Construction will take from five to ten years; work on the terminal buildings is not due to start until 1950. Precise details of the eventual layout are not yet known, but it is hoped that a report is soon to be issued by the Minister of Civil Aviation. There has been some controversy as to the respective merits of a triangulated layout such as has been started at Heathrow and the radial layout, as used in certain American airports. It will be, therefore, interesting to see whether, in the light of recent airport operational experience, any changes in the layout of London Airport are proposed.

The Ten-Year Road Plan

Last May, Mr. Barnes, Minister of Transport, in Parliament gave particulars of the Government's ten-year plan for roads. It provides for a large programme of major improvements on existing roads, both in town and country areas, and the building of some 800 miles of motorways. More recently the Minister stated that during the next two years he intended to press on as rapidly as the resources of the country permitted with the first stage of that plan, beginning with those schemes which would give help to industry, particularly in the "Development Areas." Soon he expected to invite tenders for preliminary work on the Severn Bridge, on which we give some notes below. Another major scheme, serv-

ing a development area was the proposed Jarrow tunnel, for the construction of which authority had been given. The first stage, according to Mr. Barnes, would also see resumption of work on pre-war plans, such as the lower Thames tunnel between Dartford and Purfleet. Some schemes would have to be modified; for example, it was clear that the Maidenhead and Slough by-passes would eventually form part of the route from London to South Wales, *viâ* the Severn Bridge, and the plans were being recast accordingly. Preliminary surveying work was in hand for determining the future lines of the principal trunk roads. Finally, he proposed, subject to the approval of Parliament, to put in hand during the later stage of the ten-year plan a number of motorways, linking some of the main centres of population.

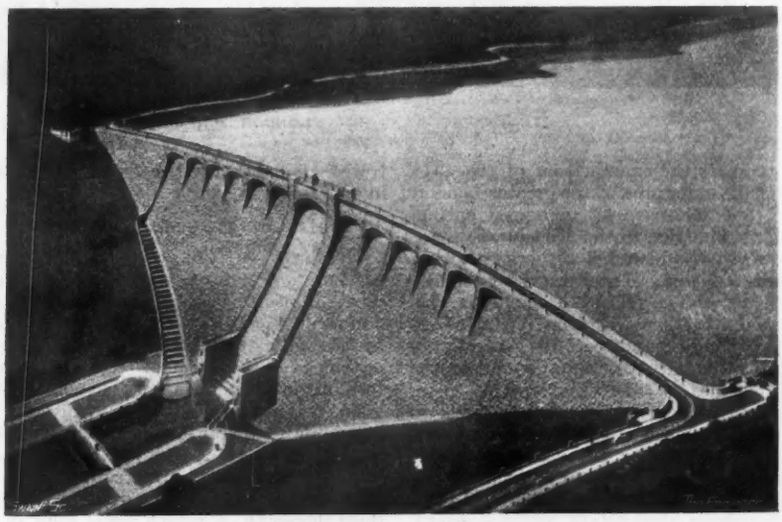
IMPRESSION OF PROPOSED BRIDGE OVER THE RIVER SEVERN

Severn Bridge

Reproduced in an accompanying engraving is an artist's impression of the proposed bridge across the River Severn. This bridge will form an important link in the future road development of the Bristol and South Wales area, and will shorten many journeys which at present must be made *viâ* Gloucester. During the year the Ministry of Transport made available the main proposals of its scheme, which includes the construction of the Severn Bridge, a bridge over the mouth of the River Wye, and approach roads on both sides of the Severn estuary, with combined total length of about 8 miles, at a cost of about £7,500,000. The main bridge will have a central suspension span of 3000ft, with shipping clearance of 110ft above high water near the towers and about 120ft in the centre. Each of the two side spans will have a length of about 1000ft. The design is for a maximum load of 150 tons and provides for two carriageways, each 22ft wide, two cycle tracks, each 9ft wide, and two footpaths, each 6ft wide. The anchorages to take the pull of the main cables will be each about 250ft long and 130ft wide, of concrete construction, and the piers will be about 200ft long and 60ft wide, also of concrete, with granite facing near the top. Each of the two towers, of steel, will rise to about 450ft above high water and will each comprise two legs about 30ft square, braced by two panels, at roadway level, at the top and at about 70ft above the roadway level. In the centre of the panel above the roadway the arms of Wales will be picked out in bright colours on the English side and the arms of England will be similarly depicted on the Welsh side. The engineers for the scheme are Messrs. Mott, Hay and Anderson, with whom are associated Messrs. Freeman, Fox and Partners. Detailed drawings of the scheme are being submitted to the Royal Fine Art Commission. The Severn Bridge will be the largest suspension bridge in Europe; its span of 3000ft compares with American suspension bridges as follows: Golden Gate, 4200ft; George Washington, 3500ft; Bronx-Whitestone, 2300ft; San Francisco-Oakland, 2310ft.

Black Sluice Pumping Scheme

An event of the year was the official opening of the Black Sluice Pumping Station of the Witham and Steeping Rivers Catchment Board in December. This south Lincolnshire fen drainage scheme serves an area of fens and marshes totalling 101,000 acres, together with 64,500 acres of high land, which drains into the South Forty Foot Drain, a "main river" under the control of the Board. Its necessity arose from falls in the level of the fen areas, due to past improvements in drainage of the locality. Pumps at the Black Sluice station are capable of discharging about three-quarters of the estimated peak flood flow and are arranged to work continuously. The station consists of an engine-room floor on which the main engines, generating plant and various smaller units and operating gear are placed; an intermediate floor or basement in which service pipes, heat exchangers and air compressors are accommodated; and the lower water passages, comprising the intake and outfall channels and the volutes for the pumps. The lowest compartments comprise complex water passages and are of special interest, as they are made in concrete in place of the usual iron castings. This work had to be executed very accurately to comply with hydraulic requirements. Entry of the water to each pump is by a double flume, which feeds the eye of the pump, 100in in diameter, and thence each volute expands in circular fashion to the discharge passage, varying from 7ft 4in wide and 6ft high to 20ft wide and 6ft 9in high. The expansion of the discharge passage is designed to effect a recovery in the pressure head and a reduction of discharge velocity to about 3ft per second at the point of discharge to a culvert leading to the outfall bay. There are three sets of these passages.



IMPRESSION OF CLAERWEN DAM

Space precludes an adequate description of the station in this article. It may be mentioned, however, that the three pumps by Gwynnes Pumps, Ltd., have a diameter of 9ft 10in and are each designed to deliver at 13ft static head 400 cubic feet per second at 70 r.p.m., with a power input of 746 b.h.p. They are driven through David Brown gears, by Ruston and Hornsby five-

cylinder turbo-charged oil engines, each developing 900 b.h.p. at 345 r.p.m. The engineer to the Witham and Steeping Rivers Catchment Board is Mr. F. H. Tomes, M.Inst.C.E.

Water Supply Schemes

There were few notable water supply schemes in hand during the year, except for Claerwen dam, on which we give some notes below, and St. Saviour's dam, Guernsey, to which we also refer. Ladybower reservoir, described in these columns a year ago, was finally completed and Digley reservoir is as yet only in its preliminary stages. Messrs. G. H. Hill and Sons (Manchester) act as consulting engineers for the two last-mentioned schemes. Digley reservoir is to be started this year and will take some four years to complete, at an estimated cost of £800,000. In our issue last week we printed a review of the work done by the Metropolitan Water Board during 1946.

Claerwen Dam

Towards the end of the year the City of Birmingham Water Committee received authority from the Ministry of Health to begin the construction of Claerwen dam, and a contract was placed with Edmund Nuttall, Sons and Co. (London), Ltd. An artist's impression of the appearance of the dam when it is completed is reproduced above, and the reader is referred to our issue of December 6, 1946, for an illustrated description of the scheme. The dam will provide additional storage in the Elan Valley, near Rhayader, in Wales, for the Birmingham area. It will have a maximum height of 182ft to crest level above stream bed and a length of 1066ft. The water impounded will make a reservoir about 4 miles long, with a capacity of 10,860 million gallons, as against the existing total storage of 11,175 million gallons. A roadway is to be carried across the dam, which will be curved in plan and will present a graceful appearance. The overflow is to be placed in the central portion of the dam, with the roadway carried over it on twelve 40ft spans and a central 60ft span. Normal overflows of the river will therefore pass under the central arch and will fall down the face of the dam over a series of steps between substantial buttresses. In times of heavier flood water will also pass under the remaining twelve arches, of which the crest levels are to be 6in higher than that of the main spillway. In addition to the dam and the ancillary river training works there are about 9½ miles of road and 4 miles of footpath to be constructed. The scheme is estimated to cost £1,700,000 and to take five years to complete. The engineers are Sir William Halcrow and Partners.

(To be continued)

Shipbuilding and Marine Engineering in 1946

No. II—(*Continued from page 23, January 3rd*)

Important Ships in 1946

In our last article we referred briefly to the completion for the Union Steam Ship Company, of New Zealand, of the twin-screw, electrically propelled steamship "Hinemoa." That ship is noteworthy for her finely panelled public rooms and staterooms, work carried out in Australian and New Zealand hardwoods by Martyn's, of Cheltenham, in association with its parent firm, Maple and Co., Ltd., of London. The work was done in accordance with the designs and instructions of McInnes, Gardner and Partners, architects, of Glasgow, a firm which acted on behalf of the owners and the ship-builders, Vickers-Armstrongs, Ltd., of Barrow-in-Furness.

The propelling machinery was designed and constructed by the British Thomson-Houston Company, Ltd., of Rugby. It consists of two separate turbo-alternator sets, each rated at 5120 kW when running at 3080 r.p.m. and 3150 volts, three-phase. Each unit is complete with its own condensing plant and auxiliaries. The sets are electrically coupled to two double-unit synchronous motors having a designed output each of 6500 s.h.p. at 220 r.p.m. The turbines are of the multi-stage impulse type with stainless steel blading and nozzle plates. Servo-motor control is applied to the automatic steam supply to the nozzles in proportion to the load. Two balancer boosters are used for excitation purposes. For controlling the flow of power from the alternators to the propelling motors a "mistake-proof" fully interlocked control cubicle is employed. We show a view of the actual control platform with the six levers and the necessary indicating instruments for enabling the engineer on duty to carry out orders in a short time with a minimum of manual effort.

There are three levers for controlling the port side and another three for controlling the starboard side. The two outer levers are direction levers for the ahead and astern rotation of the propellers, while the two inner levers are field levers for the excitation of the alternators and propelling motors, and the middle lever of each group is a speed lever for controlling the turbines from dead slow speed to a speed of 3300 r.p.m.

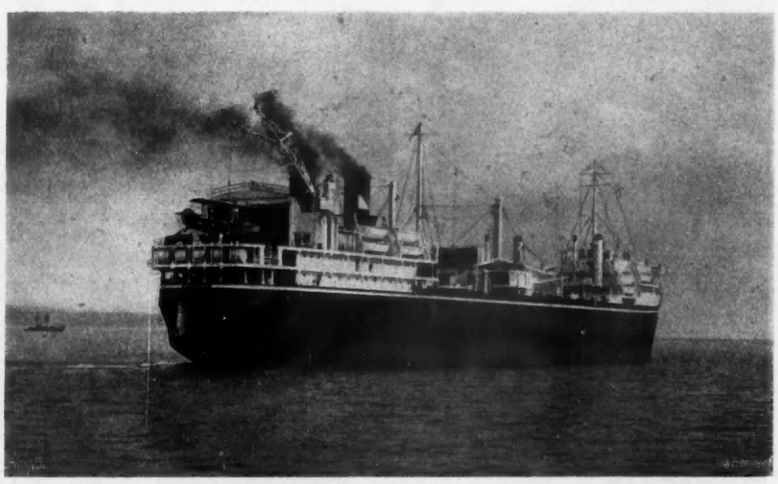
The auxiliary generating units are three in number and are contained in a separate compartment, a practice which permits a more generous lay-out of the main alternator sets and boosters. The auxiliary sets each have an output of 350 kW and are complete with condensing plant. They are geared from 6000 r.p.m. to 1000 r.p.m., and generate d.c. at 220 volts for the auxiliary lighting and cooking loads.

Steam is generated in four high-pressure Yarrow water-tube boilers, which are of the five-drum, front-fired type with curved fronts, enabling the burners to be slightly angled so as to form a common focus for the impinging flames. Steam is generated at a pressure of 425 lb at the superheater outlet, with a final temperature of 725 deg. Fah. For auxiliary electric services a 50-kW Ruston-Hornsby oil engine driving an Allen generator is provided. There is also a 50-kW dynamo driven by an induction motor, which can be supplied by 400-volt a.c. shore current when the ship is in New Zealand.

The ship has a bow rudder as well as a stern one, and Brown electro-hydraulic steering gear with telemotor control from the bridge is employed.

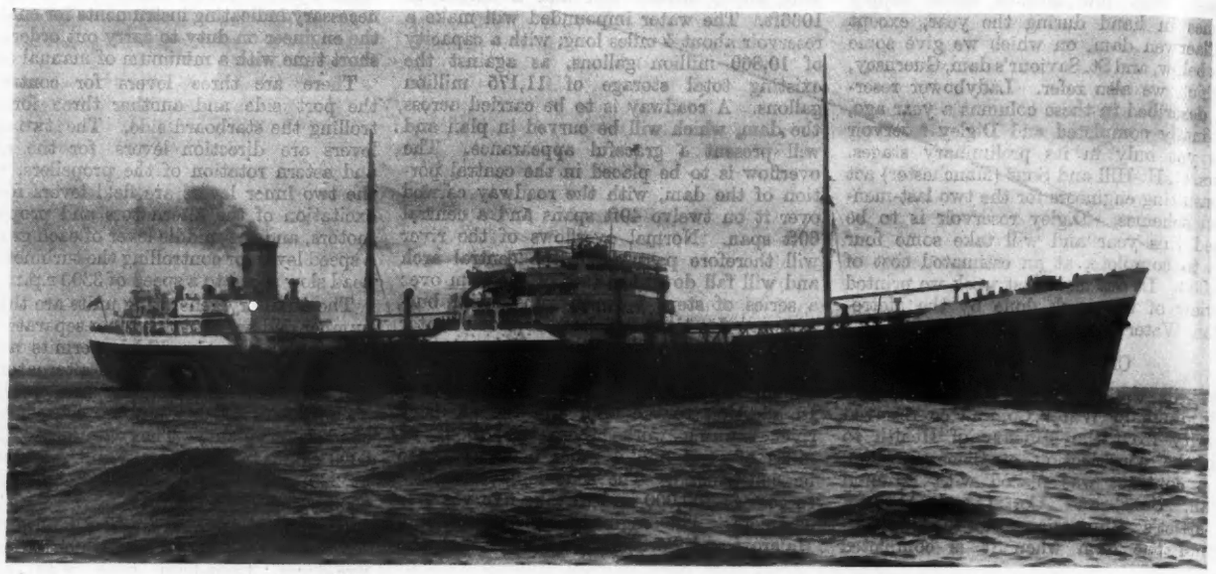
Another interesting ship of the year was the whale factory ship "Balaena," illustrated herewith, and a full description of this vessel will be found in our issue of October 11th. She was designed and built by Harland and Wolff, Ltd., at Belfast, for the Antarctic service of United Whalers, Ltd. The design includes the provision of a hangar at the after end of the ship, as shown in our engraving, in which three "Walrus" aircraft of the naval amphibian type are housed. Brown catapult launching gear is fitted. The flensing deck is made the larger by widening the ship 1ft 6in each side above the water line, giving a flensing deck 321ft in length and 77ft wide. The ship accommodation is of very high order, and the whale oil producing plant one of the largest ever installed aboard ship. The "Balaena" has a length of 535ft, a beam of 77ft at the flensing deck and 74ft moulded breadth, a displacement of 32,000 tons and a measurement of about 15,000 tons. The propelling machinery is of the N.E.M. triple-expansion reheat type for twin screws having a total designed output of 8000 s.h.p. It takes steam from single-ended Scotch boilers with a working pressure of 220 lb per square inch. For auxiliary generating plant one 1500-kW turbo-generator, two 300-kW oil engine driven generators and one 72-kW steam engine driven generator are installed, all built by W. H. Allen, Sons and Co., Ltd.

At the Furness Shipbuilding Company, Ltd., of Haverton Hill-on-Tees, another



WHALE FACTORY SHIP "BALAENA"

whale factory ship, the "Southern Harvester," was completed for Chr. Salvesen and Co. and went out to the Antarctic whaling grounds. She is a sister ship of the "Southern Venturer," illustrated and described in last year's annual review. The main propelling machinery is of the N.E.M. twin-screw triple-expansion type with superheated steam generated in Scotch boilers. The engines have a designed output of 10,790 i.h.p. The auxiliary machinery comprises six oil engine driven generating sets and one small steam set. The oil engine sets are three at 400 kW, two at 200 kW and one at 80 kW. The engines were built by Mirrlees, Bickerton and Day, Ltd., and the generators by the Brush Electrical Engineering Company, Ltd., of Loughborough. All the units are rated for continuous output under full-load conditions, if necessary, in the Tropics.



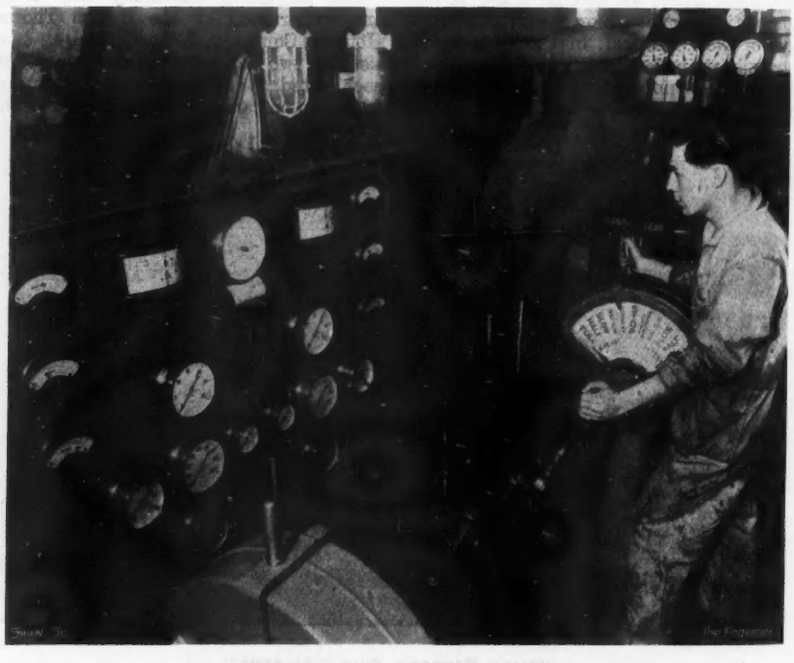
ELECTRICALLY-PROPELLED TANKER "HELICINA"

Among the many oil tankers constructed during 1946 and those on order, the "Helicina," a turbo-electric tanker designed and built by Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne, for the Anglo-Saxon Petroleum Company, Ltd., London, is an interesting ship, for she is one of the largest single-shaft propelled tankers yet built and is the flagship of the Anglo-Saxon fleet. Her Babcock boilers have been adapted to burn cracked asphalt as a boiler fuel, and the ship will thus use as a fuel a refinery by-product. The "Helicina," a view of which is given herewith, has a length of 550ft, a breadth of 70ft and a moulded depth of 40ft 6in. Her loaded draught is about 31ft 7½in, her deadweight carrying capacity 17,860 tons and her measurement about 12,250 gross tons. She had a speed of 17 knots on trial when loaded.

The B.T.H. machinery follows closely in arrangement that of her sister ship, the "Olna," which, we may recall, was taken over by the Admiralty. There are two turbo-alternator sets driving a single, double-unit synchronous type propelling motor. The designed output is 11,000 s.h.p. at maximum economy, but to be capable of maintaining 13,000 s.h.p. continuously. Steam is generated in three Babcock and Wilcox water-tube boilers with superheaters and air heaters. The working pressure is 450 lb per square inch and the superheated steam temperature 750 deg. Fah. The boiler plant of the "Helicina" and also of a third ship on order from the same builders, the "Hyalina," is designed, as mentioned above, to burn a waste product known as cracked asphalt or bitumen. It has a specific gravity of 1·06, a melting point of 165 deg. Fah., a closed flashpoint of 400 deg. Fah. and a heating value of 17,590 B.Th.U. per pound. The Redwood No. 1 viscosity of this fuel at 212 deg. Fah. is 20,000 seconds. Special experiments in burning this special fuel were made under the direction of Shell Group technicians at the works of Swinney Bros., of Morpeth, and were, we learn, successful in every way. The ship made her trials on heavy boiler oil and operated on asphalt fuel after calling at Curaçao.

The design of the machinery was developed by Mr. John Lamb, the manager of the technical division of the Anglo-Saxon Petroleum Company, Ltd., in conjunction with the engine and the shipbuilders.

Another Anglo-Saxon tanker of the year in which Mr. Lamb also played an important part was the "Auricula," built by R. and W. Hawthorn, Leslie and Co., Ltd., and propelled by Hawthorn-Werkspoor four-stroke, single-acting oil engines, pressure charged. The ship has a deadweight carrying capacity of 12,200 tons and a speed of about 12 knots, the engines developing about 4200 i.h.p. The "Auricula" has engines designed to run on high-viscosity boiler fuel. A special single-cylinder test engine was run on this fuel, which, at 100 deg. Fah., has a Redwood No. 1 viscosity figure of 1500 seconds. The voyages already made by the "Auricula" with heavy oil fuel have been satisfactory. Some little trouble was experienced during the first voyage to Curaçao



CONTROL PLATFORM OF S.S. "HINEMOA"

with pipes in the injection system owing to the higher injection pressures employed, but was overcome.

Cross-Channel Ships

One of the first reconverted cross-Channel ships to go into service in 1946 was the Southern Railway Company's steamer "Canterbury." Her reconversion was carried out by Vickers-Armstrongs at Walker Naval Yard. An illustration of the ship is given in one of to-day's special Supplements. She was designed and built by William Denny Brothers, Ltd., of Dumbarton, in 1929 and carries about 1300 passengers. The accommodation now provided is excellently arranged. The "Canterbury" has a length of 329ft 7in, a beam of 47ft and a depth of 16ft 10½in, her measurement being about 3071 tons. The propelling machinery consists of a twin-screw arrangement of Parsons compound steam turbines with single-reduction gearing taking steam from four Babcock and Wilcox oil-fired water-tube boilers. As already stated, in our last article, the "Canterbury" is now on the Folkestone-Calais service of the Southern Railway Company.

In May, 1946, the Götaverken Shipbuilding Company, of Gothenburg, completed and delivered to the Swedish Lloyd Company the motor vessel "Saga," designed for the company's Gothenburg-London service, which is also shared by the two Swan, Hunter-built steamers, the "Suecia" and "Britannia." A view of the "Saga" is reproduced in one of our Supplements. Later in the year she presented a fine sight when she berthed alongside Adelaide House at London Bridge. She is the largest passenger ship to be built by Götaverken. Her principal dimensions are as follows:—Length, 420ft 10in; breadth, 55ft; depth moulded to shelter deck, 32ft 11in. Her gross tonnage is 6545 and she is designed to carry 2150 tons of cargo on a draught of 18ft 11¼in. Her passenger accommodation is excellent, both in lay-out and decorations, and it is arranged to carry about 400 passengers for short sea passages or cruises in first, second and third classes. Additional group cabins are provided for the use of young students.

The propelling machinery was designed for a service speed of about 18½ knots, and on the official trials a mean speed of 19·4 knots was attained. There are four eight-cylinder Götaverken pressure-charged four-stroke engines, which are coupled to a single propeller through A.S.E.A. electric slip couplings and gearing. The main engines have a bore of 500 mm and a stroke of 700 mm and run at 270 r.p.m., the total designed output being about 6700 s.h.p. The auxiliary generating sets are of Götaverken make and are four in number, coupled to 140-kW dynamos.

In June, 1946, a new Danish motorship, the "Kronprins Frederik," belonging to the United Steamship Co., Ltd., of Copenhagen, entered the Harwich-Esbjerg service. She is illustrated in one of our Supplement pages and was built by the Elsinore Shipbuilding and Engineering Company. Actually she was launched in 1941, but was laid up during the German occupation owing to the want of British propellers and other fittings. Her principal dimensions are as follows:—Length overall, 375ft 6in; breadth moulded, 49ft 9in; depth moulded to "C" deck, 20ft; loaded draught, 18ft 6in; displacement, 5142 tons; and measurement, 3895 gross tons. Her designed trial speed was 20½ knots. The propelling machinery consists of a twin-screw arrangement of Burmeister and Wain single-acting, two-stroke, trunk-piston engines with airless injection of fuel and independent blowers. The engines are ten-cylinder units with a bore of 500 mm and a stroke of 900 mm. When running at 165 r.p.m. the combined output is 8400 i.h.p. High-class passenger accommodation for 143 first-class and 159 second-class passengers is provided, and in summer time about fifty-four additional deck passengers may be carried. The "Kronprins Frederik" has a good cargo capacity with modern cargo-handling appliances.

Towards the end of 1946 the Denny-built cross-Channel steamer "Invicta" was reconverted by Vickers-Armstrongs, Ltd., at Walker and was put on to the "Golden Arrow" service, making the Dover-Calais run on the London-Paris service. The "Invicta" was completed just as war broke out and she immediately went into trooping service and was never employed as a passenger ship. She did noteworthy service with combined operations. Originally she was designed to burn Kent coal, which was fed through gravity bunkers to Taylor stokers fitted to two Yarrow water-tube boilers. For post-war service, however, the coal-burning arrangement was dispensed with and oil firing on the Wallsend-Howden principle was substituted. The "Invicta" is the largest ship ever built for the cross-Channel service to France. She has a measurement of 4178 gross tons and a length of 350ft with a 50ft beam and a depth of 24ft 6in. Accommodation is now provided for about 1300 passengers, first and second class. The ship, as our Supplement engraving shows, has good enclosed promenade deck space; there are two continuous decks, the main and the upper deck, with a promenade deck extending almost the whole length of the ship. Among the public rooms are a tea lounge, restaurants and dining room, and smoke room. Wing cabs on the bridge and a bow rudder, in addition to the ordinary rudder, enable the ship to approach harbour stern first and to berth conveniently.

(To be continued)

Gas Turbine Development in 1946

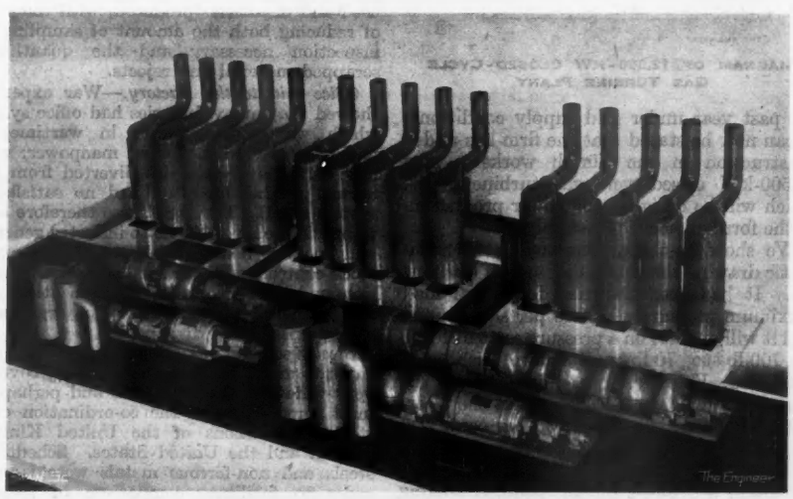
No. II—*(Continued from page 14, January 3rd)*

IN our last article we made brief mention of the important gas turbine order placed in June, 1946, with Brown Boveri and Co., Ltd., of Baden Aargau, Switzerland, by the North-East Swiss Power Company for the setting to work of a 40,000-kW gas turbine power station at Beznau. The installation will consist of two units, the first of 13,000 kW, which is to be placed in commission at the beginning of the winter of this year, and the other, a 27,000-kW unit, which will be completed and put in operation before the beginning of winter 1948. Both of these new units are to be of the open-cycle high-efficiency type, with a two-shaft arrangement, and the design includes large heat interchangers and intercoolers for the air compressors.

The units are to be designed to utilise furnace oil as the fuel. They will have a gas temperature at the turbine inlets of 600 deg. Cent. or 1112 deg. Fah., and have been designed for an ambient air temperature of 5 deg. Cent. or 41 deg. Fah., and a cooling water inlet temperature of 5 deg. Cent. or 41 deg. Fah. These temperatures, it may be noted, have been chosen so as to comply with the winter operating conditions, as the Beznau power station will be called upon to operate during winter months.

The 13,000-kW set will be designed for continuous operation at that power, and it will have an alternator rating of 16,000 kVA, 8000 volts, three-phase, 50 cycles. The set will run at a speed of 3000 r.p.m. Its overall efficiency will be 30·6 per cent.

The 27,000-kW unit will also be designed for continuous operation at 27,000 kW, with an alternator rating of 33,000 kVA, 8000 volts three-phase, 50 cycles, and it will also run at a speed of 3000 r.p.m. The overall efficiency of this larger set will be, it is expected, 34 per cent.



LAY-OUT MODEL OF 40,000-KW GAS TURBINE POWER STATION AT BEZNAU

In the accompanying engraving we are able to reproduce a photograph of the special model prepared by Brown Boveri in order to show the design and lay-out of this large gas turbine power station. The 13,000-kW unit on the left-hand side and the 27,000-kW unit on the right-hand. In front of the turbine units the high-pressure and the low-pressure combustion chambers will be seen, while at the back the batteries of heat exchangers are visible, five for the smaller and ten for the larger gas turbine

unit. The air compressor intercoolers and the air coolers for the alternators are not shown in the model, as they will be housed in the basement below the sets.

The overall length of the Beznau power house turbine room will be approximately 220ft and the width 55ft.

ESCHER WYSS ENGINEERING WORKS, LTD., ZURICH, SWITZERLAND

In our previous article we were able to state that John Brown and Co., Ltd., of Clydebank, Glasgow, had during 1946 negotiated with the Escher Wyss Engineering Works, Ltd., of Zürich, Switzerland, the sole British and Empire licence for the manufacture and sale of the Ackeret-Keller (A.K.) closed-cycle gas turbine system for both land and marine purposes.

We made reference to the running of the 2000-kW experimental set at Zürich during

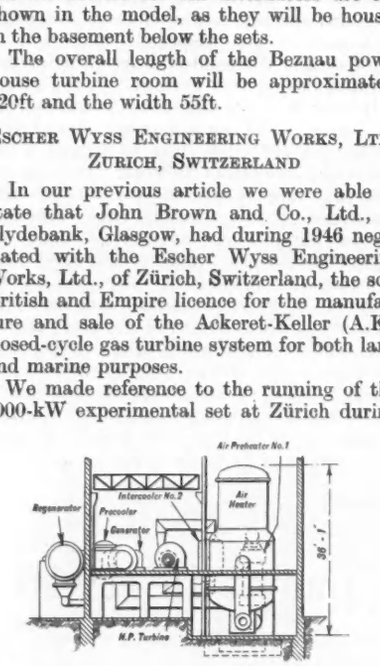


DIAGRAM OF 12,500-KW CLOSED-CYCLE GAS TURBINE PLANT

the past year under grid supply conditions. It can now be stated that the firm has under construction in the Zürich works a new 12,500-kW closed-cycle gas turbine plant, which will be designed for power production in the form of electricity supply.

We show in the accompanying diagrammatic drawing the general lay-out of this new set. It has been designed for a full load maximum pressure of 700 lb per square inch and it will operate on a pressure ratio of 10 : 1 or 700 lb to 70 lb per square inch. At 1200 deg. Fah. gas inlet temperature the guaranteed efficiency, measured at the alternator coupling, is given as 35 per cent, and at 1300 deg. Fah. the efficiency is expected to be about 37 per cent. These efficiencies, we learn, are based on an assumed cooling water temperature of about 55 deg. Fah., and they include all the auxiliaries.

The drawing clearly shows the arrangement of the precooler, the four air compressors, the intercooler, the regenerator, and the air heater and the two gas turbines. Both the initial heating of the air and its reheating between the high-pressure and the low-pressure turbines takes place in the single air heater, which is supercharged to a pressure of about 40 lb per square inch by a radial type blower driven by an exhaust turbine. Control and charging compressors form part of the regulating system, and are designed to change the density of the air in the working circuit, in order to meet any load changes without variation of temperature.

(To be continued)

Wartime Work of the B.S.I.

(Contributed)

AT the outbreak of war, in 1939, all work not considered essential for industry in wartime was deferred so that practically the whole of the work of the British Standards Institution during this period was related to the war effort. Several hundreds of war-emergency standards and amendments to ordinary standards were issued during the war years, in close collaboration with various Government Departments and with industry, and the following are some examples of these activities :—

Civil Defence Requirements.—Sixty-eight specifications were issued in collaboration with the A.R.P. Division of the War Office. These standards ranged from black-out materials to material for construction of shelters, stirrup pumps, and protection against incendiary bombs. To deal with street lighting and special lighting fittings, the B.S.I. worked in close collaboration with the Joint Lighting Committee set up by the Ministry of Home Security and The Illuminating Engineering Society—the manufacture of the lighting fittings was controlled by test methods laid down by the Mark Committee of the B.S.I.

Packaging.—Packaging played an important part in war production, and in 1942 a schedule of sizes and types of packages of pre-packed commodities for the home trade was issued. In December, 1943, the Institution issued a Packaging Code, which had been prepared at the request of the Anglo-American Packaging Committee of the Ministry of Production; this was a comprehensive treatise describing packaging materials and containers, the purpose for which they were most suitable, how they could best be tested, and how used to the best advantage. A supplement was subsequently prepared, giving similar recommendations relative to packaging for tropical countries.

Quality Control.—The B.S.I. Committee on Quality Control, assisted the Ministry of Production in putting on a statistical basis the routine sampling and inspection of materials used and of articles produced, with the object of reducing both the amount of sampling and inspection necessary and the quantity of scrapped material and rejects.

Office Aid to the Factory.—War experience showed that many factories had office systems which were over-elaborate in wartime, and made excessive demands on manpower, whilst new factories or factories diverted from their normal production often had no satisfactory system at all. The B.S.I. was therefore asked to provide some guidance to industry generally, and booklets dealing with production control, stock control and store keeping, office organisation and practice, office mechanisation, payroll methods, and drawing office organisation were prepared and distributed.

Steel Specifications.—The work done by the Institution for the Ministry of Supply covered a very wide range of materials and perhaps the most important was the co-ordination of the steel specifications of the United Kingdom, Canada and the United States. Schedules of steels and non-ferrous metals were issued in order to facilitate comparison of materials supplied by these countries.

Screw Thread Standardisation.—Several Conferences were held in the United States, in Canada, and in Great Britain, with regard to screw thread problems directly related to the war effort, which were then satisfactorily solved. Consideration was also given to the old and difficult question of the unification of British and American screw threads, and although final agreement has not yet been reached, investigations are still proceeding.

The importance of this work can be judged from the fact that it was competently estimated that at least £25 millions was added to the cost of the war by the difference between British and American standards for screw threads.

Post-war Building.—During the war, the Directorate of Post-war Building of the Ministry of Works set up a Standards Committee to study the application of standard specifications in building, and to make recommendations on the preparation of British Standards. As a result, British Standards are now available for the whole range of materials and components required for the housing programme.

A comprehensive scheme for British Standard Building Codes has been prepared and several have been issued—a Code of Practice is a statement of the methods by which materials can best be used to perform certain required functions, and their importance in ensuring a high standard quality of workmanship will, therefore, be appreciated.

INTERNATIONAL STANDARDS

In 1944 the national standards bodies of the United Kingdom, U.S.A. and Canada formed the United Nations Standards Co-ordinating Committee, a body which was, in October, 1946, formally convened as the International Organisation for Standardisation upon which the national standards bodies of 25 countries are represented. The object of the new organisation will be to facilitate the co-ordination and unification of the standards of the member bodies, which shall be the National Standards organisations that have agreed to abide by the Constitution and Rules and have been admitted into the Organisation in accordance with the defined procedure. International standards will only be issued with the approval of all member bodies.

Technical Reports

Open-Textured Asphalt Carpets.—The Road Research Laboratory of the D.S.I.R. has carried out road trials on a limited range of carpets made with asphaltic bitumen binders and designed to secure a durable surfacing, which will maintain an open non-skid texture without subsequent treatment. The results are given in Road Research Bulletin No. 5, "Recommendations for Open-Textured Asphalt Carpets," published by H.M. Stationery Office, price 3d. Some eight years ago the Road Research Laboratory, in co-operation with the Ministry of Transport, started a comprehensive series of road trials, backed by laboratory experiments, to investigate the basic principles underlying the design of bituminous carpets, and to determine the limits of composition within which durability is combined with a sufficiently open surface texture. More than 800 experimental carpets were laid, and the experiments included a study of two main types of aggregate, crushed rock and gravel, and several types of tar and asphaltic bitumen binder. The recommendations in this bulletin refer to carpets containing asphaltic bitumen binders. The carpets described are by no means the only ones capable of satisfactory application, but of the compositions tried experimentally they are known to have the longest life consistent with maintaining a satisfactory open surface texture. Crushed rock and certain slags are preferable as aggregates for asphalt carpets, but satisfactory carpets can be made with gravel. When gravel is used, the mix should contain a higher proportion of fine aggregate and a higher binder content. Separate recommendations are given for carpets made with gravel aggregate. This bulletin was originally issued in 1941 as Wartime Road Note No. 3, with the same title. Repeated requests have been received from road engineers for the note to be reprinted. Only minor alterations have been made to the original text. It is proposed to issue at an early date recommendations, based on the latest experimental results, covering the whole range of asphalt carpets.

THE BIDWELL BAR BRIDGE.—The suspension cables in the Bidwell Bar bridge, are still in place after ninety years of service. All the materials for the bridge, which is to be taken out of active service on the completion of a new bridge downstream, were brought "around the Horn" on sailing vessels and hauled overland some 200 miles to the town of Bidwell Bar, near Oroville, California. *Engineering News-Record* recalls that this 240ft bridge which spans the south fork of the Feather River was built in 1856 for some 35,000 dollars by the Bidwell Bridge Company, an organisation formed for the purpose, which operated it as a toll bridge until 1889. The origin of the materials making up the bridge is difficult to determine as the records of the original company have been lost. However, the towers bear the markings "Made in Troy, New York."

Electrical Engineering in 1946

No. I

IT is impossible to assess progress in electrical engineering without first appreciating how closely electricity is interwoven with the fabric of modern industry. No longer a luxury, electricity is to an ever-increasing extent becoming one of the most important raw materials of production. There is hardly an industry to-day that does not turn to electricity for the application and accurate control of heat, power or light; for making precise measurements or indirectly for controlling some mechanical or physical process; or for intercommunication. Inasmuch as electricity can help to increase productivity and raise efficiency, the growth of the electrical industry is a measure of progress. But this progress cannot avoid, though it may mitigate, the effects of today's austerity, when the same shortages of manpower, tools and raw materials afflict almost every enterprise and when the difficulties which restrict the output of one industry, such as electricity supply, immediately influence the workings of so many other industries.

Electricity Supply

Two new major problems have confronted the electricity supply industry during the past year of reconversion from wartime to peaceful activities. The first problem to arise concerns the attitude of the various sections of the industry to the Government's proposals for nationalising electricity supply. After long preliminary discussions the Incorporated Municipal Electrical Association (representing some 60 per cent of the authorised supply undertakings in this country), accepting the principles of State ownership, agreed to discuss the forthcoming proposals with the Minister of Fuel and Power. The company-owned undertakings, however, took the opposite view. Through their various associations the companies unanimously expressed their uncompromising opposition to the principle of State ownership of the industry. Stating fully their reasons for this decision, the companies rejected the Minister's invitation to discuss the proposals for nationalisation.

This controversial issue is over-shadowed temporarily by the more immediate practical urgency of another problem. The necessity for load shedding, which was avoided throughout almost the whole of the first post-war winter, has in recent weeks become an unpleasantly regular occurrence. It will be appreciated that these cuts in electricity supply have not been caused by lack of coal, although coal supplies to power stations have in the past and may again in the future give rise to anxiety. The present critical situation is, in fact, the result of an acute shortage of generating plant. It must also be acknowledged that the present deficiency in generating capacity is a direct consequence of the war, during which, as part of the price for victory, all long-term development plans were drastically curtailed and the manufacture of generating plant for installation in this country was brought virtually to a standstill. Unfortunately, the very nature and magnitude of the deficiency precludes the application of any short-term remedy—apart from voluntary economy in the use of electricity—and the shortage, with its attendant consequences, may well be intensified during the next two winters and cannot in any event be cured much before 1950.

The problem is, of course, aggravated by a very rapid rise in the demand for electricity following a temporary lull after the peak year of 1944. In round figures, the present connected load is greater by about 1 million kilowatts than it was twelve months ago. The growing consumption of electricity is perhaps best illustrated by comparing the number of units generated by authorised undertakings in 1945 and 1946. The generated outputs in the months of August, September and October, 1946, were respectively 15 per cent, 14·7 per cent and 17·4 per cent greater than in the corresponding months of 1945!

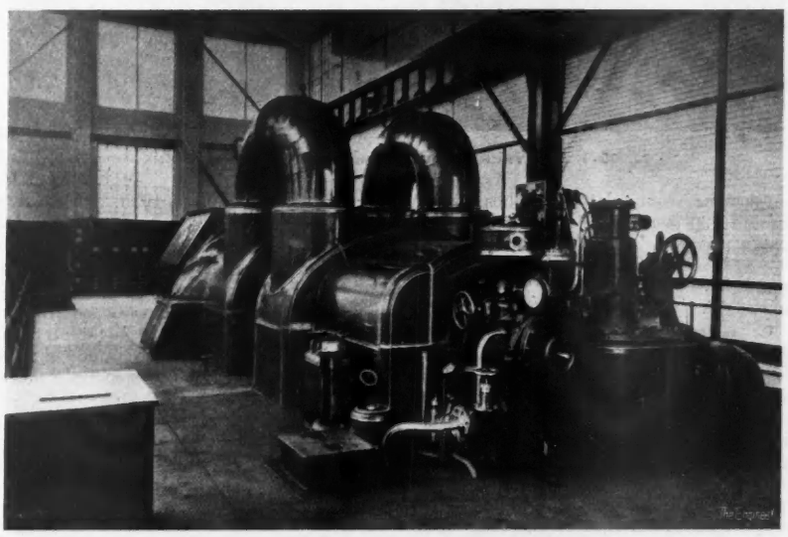
To complete this brief background to the present position it may be added that the C.E.B., foreseeing the inevitable consequences of the enforced interruption of normal development, put in hand construction programmes as and when priorities permitted during the war. As a result arrangements have been made for increasing the generating capacity of authorised undertakers by approximately 6 million kilowatts by the end of 1950. The earlier part of this programme included some 900,000 kW, which was due for commissioning in 1946. Unfortunately, as foreshadowed in the Board's eighteenth annual report, this work fell behind schedule both on site and in the manufacturers' works on account of labour shortage. Although the situation showed some improvement recently, the effect of the inevitable time lag is that slightly less than one-third of the projected 900,000 kW was actually in commission by the end of 1946. It is anticipated that the deficit may be reduced by about 150,000 kW before the end of the present winter.

The new generating plant put into service during the year includes a 53·5-MW set at Hams Hall "B," a 30-MW set at Willesden (London Power Company), a 20-MW set at Bonnybridge and another at Warrington, a 60-MW set at Fulham and a 30-MW set at Hull.

Included in the aggregate expansion of 6 million kilowatts, scheduled for completion by the end of 1950, is a total of 1,029,000 kW for which the C.E.B. made arrangements with authorised undertakings in the first seven months of 1946. In this scheme the additional plant due for commissioning by the winter of 1948 includes 150 MW at Barking (County of London Company), 64 MW at Rye House (Northmet Company) and 100 MW at Poole (Bournemouth and Poole E.S. Company). New stations provided for in the same programme are Skelton Grange (Leeds), 120 MW; Staythorpe (Derby and Notts Company), 120 MW; Rye House and Poole.

Hydro-Electric Developments

Satisfactory progress has been made with the North of Scotland Hydro-Electric Board's programme, which, as originally outlined, envisages the development, in a ten-year period, of twenty-seven water power stations, transmission lines and distribution networks, providing a generating capacity of 811 MW with an output of 2250 million units. These developments will cater for the prospective demands of the existing consumers and authorised electricity undertakings, for new domestic consumers and for the needs of the C.E.B.



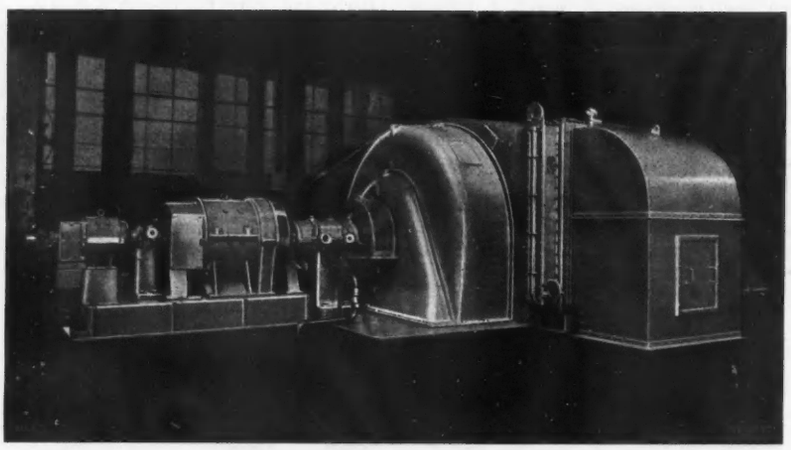
20,000-KW Set at Huddersfield

In the space available it is evidently impracticable to attempt a review of the Hydro Board's activities, and we must content outselves with a brief reference to two of the Board's schemes published during the year.

After nearly two years' work involving the consideration of many and sometimes conflicting local interests, details have been given of the Mullardoch-Fasnakyle-Affric Hydro-Electric Scheme (Constructional Scheme No. 7). This project will preserve as far as possible the amenities of the area and will leave Loch Affric unaffected, overcoming some of the objections raised against two earlier schemes that were proposed by the Grampian Company in 1928 and 1941 and were rejected by Parliament. The Board's scheme involves the construction of a dam 120ft high at Loch Mullardoch (to raise the level by 113ft) and a tunnel diverting its waters to Loch Benevean through an underground power-house. A dam at Loch Benevean will raise the water level there by only 25ft and a second power station will be built at Fasnakyle. The two stations will have a total installed capacity of about 70 MW with an average annual output of about 250 million units. The estimated cost of the scheme is £4,800,000.

Another project (known as Distribution

Scheme No. 10) is designed for supplying electricity to the Loch Carron and Loch Kishorn districts of Ross and Cromarty. The Board will transmit electricity from the Nostiebridge power station of the Lochalsh scheme to Stromeferry; a submarine cable, half a mile long, will cross Loch Carron narrows to Stromemore. When this distribution scheme is completed supplies will be available to 90 per cent of the population in the area served.



10,000-KVA SYNCHRONOUS CONDENSER FOR PALESTINE

Transmission and Distribution

Progress in the transmission and distribution of electricity was marked by two important steps towards standardisation. First, the transmission of power should be considerably facilitated by the introduction of a new British Standard (No. 1320 : 1946) dealing with h.v. overhead lines on wood poles for voltages not exceeding 11kV, with conductors of up to 0·05 square inch cross section. By giving approval to a simplified transmission line construction, which has been thoroughly tested in practice, this specification should facilitate the much-needed extension of rural electrification.

The second event was the decision, announced in Parliament by the Minister of Fuel and Power, early in 1946, to adopt 240 volts as the standard for low-voltage a.c. supplies throughout the country. Subsequently discussions proceeded with the supply associations concerned regarding the steps necessary to implement this decision. In the meantime the Electricity Commissioners approved, for low and medium-voltage supply, a standard a.c. 50-cycle system, at 240 volts on two-wire single-phase circuits, at 480/240 volts on three-wire single-phase circuits, at 415/240 volts for four-wire three-phase circuits and 415 volts on three-wire three-phase circuits. The prescribed date for the introduction of this standard is October 1, 1947.

Manufacture

Although the electrical manufacturing industry as a whole made noteworthy strides in the conversion from war to peace-time production, activity in certain fields was restricted by difficulties concerned with raw materials and manpower. To some extent these two matters are inter-related, since the scarcity of ceramics and iron castings, for example, is largely attributable to shortage of skilled labour in the primary industries concerned.

A general idea of the manpower situation can be gleaned from figures published by the Ministry of Labour and National Service. The total labour force employed in electrical engineering remained practically constant throughout 1946 at what may be regarded as the post-war datum level. Taking June as a representative month for the purpose of comparison, the total number of persons employed in the industry was 151,400, which was approximately 25 per cent fewer than in the peak year of 1943, but was still some 13 per cent more than in 1939. These figures would be misleading, however, if one failed to take account of the fact that the increase of 13 per cent is made up entirely of female labour, while the number of male employees has in fact decreased very slightly. In certain occupations, such as foundry work, in which male labour is employed almost exclusively, there is in fact a distinct shortage of manpower.

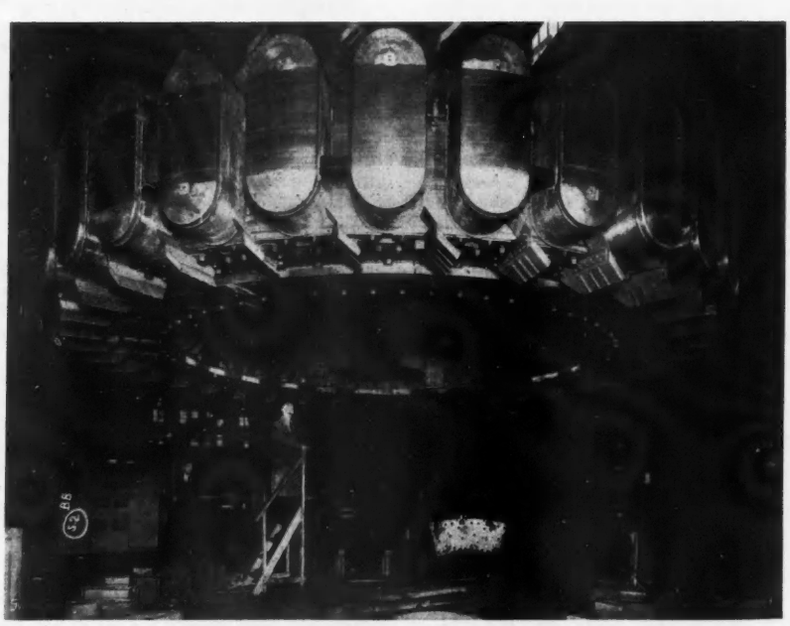
The activity of the electrical industry can be gauged to some extent by its contribution to the export trade of the country. Since the kind of exports and their volume are largely regulated by the Government, undue significance should not be attached to export figures when they are being compared with the corresponding figures for pre-war years. Nevertheless, it is evident that the electrical manufacturing industry made an encouraging start in assisting reconstruction of this country's post-war economy. Taking the latest available figures as an index, the average monthly tonnage of electrical machinery exported in October and November, 1946, was 5060 tons, an increase of about 50 per cent over the corresponding monthly figure of about 3700 tons in 1938.

Wireless receiving sets provided evidence of very striking changes; in recent months the number of sets exported has been nearly five times the monthly average for 1938.

Another view of the picture can be obtained by considering a typical month, such as September, 1946, when the value of electrical goods exported was £3·89 million, or 115 per cent greater than the average monthly figure for 1938. Further examination of the September figures shows that a substantial contribution towards the total of £3·89 million was made by radio apparatus, which accounted for nearly £600,000; wires and cables were valued at nearly £568,000 and telegraph and telephone apparatus at £417,000; these figures were respectively four times, twice and 1·75 times the corresponding monthly averages for 1938. The same comparison between 1946 and 1938 for heavy electrical machinery exports shows satisfactory if less spectacular improvements; large generators (valued at £195,000) represented a 64 per cent increase, and motors (valued at £265,000) an 83 per cent increase.

Interesting changes since 1938 can be noted in the distribution of Great Britain's electrical exports. The bulk of these exports still goes to British India, the Union of South Africa, Australia and New Zealand; but exports to certain countries, including Belgium, Holland, Turkey and Iran, have increased greatly, in many instances by more than 500 per cent. These trends are significant, for although the position is influenced by the disappearance of German exports, the recognition and fostering of these new markets is a welcome augury for the future.

In the space available it is obviously impossible to attempt a complete survey of electrical manufacturing activities, but the following brief account is intended to show as far as possible a representative cross section of the industry in 1946.



ROTOR OF A 33,333-KW VERTICAL WATER-DRIVEN ALTERNATOR FOR NEW ZEALAND

Generating Plant

An interesting development has been the use of gas turbines as prime movers for

generating sets in power stations. Progress in this field is described in our review series of articles on gas turbine developments. Swiss firms were the first to engage in this work and several plants were under construction in 1946, including a 10,000-kW Brown Boveri set and a 12,000-kW Escher-Wyss set.

Although British manufacturers are now actively engaged in developing the gas turbine for stationary applications, their main endeavour has been to increase the production of conventional steam power station equipment in an effort to meet the present unprecendented demand for generating plant. The execution of repeat designs is symptomatic of the urgent need for achieving the maximum possible output of generating capacity in the shortest possible time. Both for the home and export markets all firms report full order books.

For example, the Metropolitan-Vickers Electrical Company, Ltd., has under construction more than sixty machines with an aggregate capacity of some 2 million kVA. Of these machines, twenty-four are of more than 30-MW capacity and ten are for voltages of 22 kV or 33 kV. Some of these sets are fitted with direct-coupled a.c. house generators and have motor-driven main and pilot exciters. A special type of flexible coupling for use with direct-coupled exciters on the largest 3000 r.p.m. generating units has been developed and tested.

C. A. Parsons and Co., Ltd., has received orders for turbo-alternators of 50-MW capacity and over for Dunston, Rotherham, Birmingham, Glasgow, North Tees and Leeds, making a total of approximately 600 MW of new plant. All these machines will operate at a speed of 3000 r.p.m. and the turbines will have the three cylinders with a double flow l.p. cylinder. The same firm has received an interesting order from India for an ammonium sulphate factory at Sindri, Bihar. The plant will comprise two 12·5-MW back-pressure turbo-alternators and four 15-MW condensing sets, all operating at 3000 r.p.m. The back-pressure turbines will exhaust at 25 lb per square inch gauge and will be arranged for steam extraction at 138 lb per square inch gauge when operating at the maximum load of 12·5 MW. Steam will be extracted from the four condensing sets at two different pressure points: the first at 120 lb and the second at 40 lb per square inch gauge when operating at the maximum load of 15 MW. Among the large number of contracts completed at the Heaton works during 1946 were the third 53·5-MW set at Hams Hall "B" Station, and the second 40-MW set at Earley (Reading).

Included in the new generating plant completed by the B.T.H. Company, Ltd., and commissioned in 1946 are a 20-MW at the Bonnybridge power station of the Scottish Central E.P. Company, and a 30-MW at the Willowholme station of Carlisle Corporation. This set, illustrated in our Supplement, runs at 3000 r.p.m. and generates at 11 kV. For the Ministry of Supply the same firm has completed ten 2500-kW and 550-kW transportable turbo-alternator sets for the U.S.S.R., Czechoslovakia, Burma, Malaya and China. The set illustrated on page 55 is a 20-MW English Electric set commissioned in 1946 for Huddersfield Corporation. Included in the plant on order from the same company are a number of large units for export and a third 50-MW, 3000 r.p.m. set with hydrogen-cooled alternator for Birkenhead.

Generating plant manufactured by the General Electric Company, Ltd., for the home market includes the 30-MW turbo-alternator illustrated in our Supplement, recently commissioned at the Sculcoates power station, Hull. The two-cylinder tandem turbine with double flow l.p. turbine and twin condensers runs at 3000 r.p.m. and the alternator generates its output at 22kV.

An interesting export contract for a large synchronous condenser was completed by the G.E.C. for the Reading power station of the Palestine Electric Corporation. This machine, illustrated herewith, is rated at 10,000 kVA, 6·3/6·9 kV, three-phase, 50 cycles per second, 1000 r.p.m., and is designed primarily for correcting the power factor of the load, which consists mainly of a large number of small motors driving irrigation pumps. The condenser is also designed to provide 4000 kVA at zero lagging power factor for certain conditions when only a small load is connected to the network. To maintain stable excitation under such conditions the machine is provided with a pilot exciter in addition to the main exciter. A 500 h.p. synchronous induction pony motor is directly coupled to the main machine for starting purposes. All these machines are accommodated on a common bed-plate, the condenser being mounted between the two exciters and the pony motor. For short periods the synchronous condenser is sometimes required to operate as a generator, when it is driven by the pony motor and delivers about 350 kW.

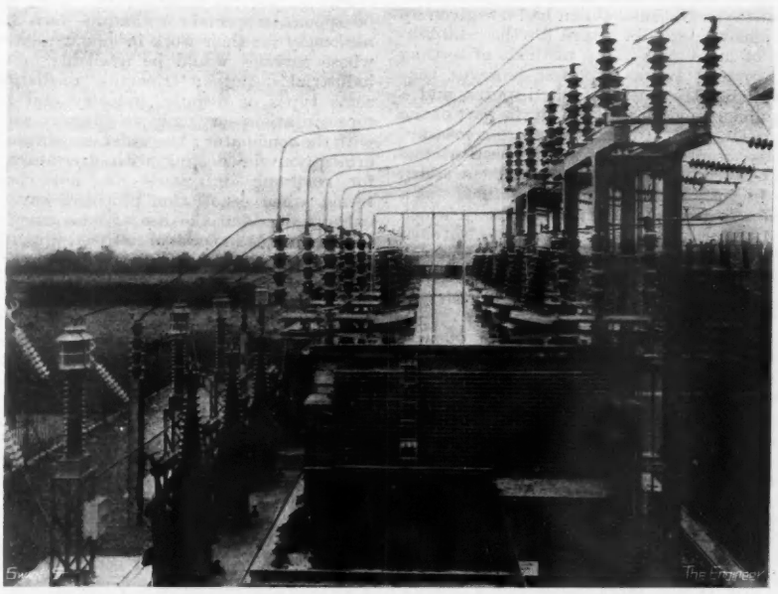
Hydro-electric generating plant figures prominently in the activities of many manufacturers. A good example of this class of machine is provided by the three 33,333-kW, 11-kV, 167-r.p.m. vertical generators built by Metropolitan-Vickers Electrical Company, Ltd., for service in New Zealand. The generators, each of which weighs 330 tons and has an overall diameter of 34ft, are the largest of their kind so far built in this country. The 36-pole rotors of these machines weigh 136 tons each. One of the rotors is illustrated in an accompanying engraving during the operation of lowering the field system on to its supporting bracket. The design incorporates a spring loaded thrust bearing providing for a total axial load of 750 tons.

Conspicuous among orders received by Bruce Peebles and Co., Ltd., is the contract for the complete generating plant for the Hydro-Electric Board's Loch Fannich scheme. This plant will comprise two 16,000 h.p. Francis turbines for a water head of 500ft, each coupled to a 10-MW, 11-kV, 500-r.p.m. vertical-shaft alternator.

Switchgear

Switchgear design and practice during 1946 has undergone few major changes, but the parallel development of air-blast and oil-immersed gear, for the highest voltages and rupturing capacities, is interesting. In the present state of the art there would appear to be useful fields for both kinds of switchgear, and the position was well summarised at a recent I.E.E. meeting, when two papers* were presented and discussed.

An installation of unusual interest is the C.E.B.'s sub-station at Andover illustrated herewith, the first complete 132-kV air-blast sub-station to be erected in this country. The installation comprises six of the B.T.H. Company's indoor pattern "Aerojet" air-blast circuit breakers, each of which incorporates resistance switching and has a rupturing capacity of 1500 MVA at 132 kV. Current transformers are carried in the roof bushings, which bring the line connections to the circuit-breaker terminals. Air drying by refrigeration is included in the compressed air installation, which embodies a new and comprehensive protective alarm system.



132-kV C.E.B. Sub-Station at Andover

Another interesting development is concerned with improvements in ring main equipment designed to make the best use of floor space and height in sub-stations where these dimensions are limited. One of the firms that has been responsible for these improvements is Ferguson, Pailin, Ltd. In a group of 33-kV ring main equipments now nearing completion at their works, compactness has been so successfully accomplished that it will be possible to accommodate the new units in existing buildings which were laid out for 6·6-kV switchgear. One of these new units consists of an oil circuit breaker (type "VRP32") of 500 MVA breaking capacity with spring-closing mechanism and two sliding rod wing isolators with butt contacts, capable of making and breaking the full-load current of 400 amperes.

(To be continued)

* "The Extinction of Arcs in Air-Blast Circuit Breakers" by Allen and Amer, and "The Influence of Resistance Switching on the Design of High-Voltage Oil Circuit Breakers" by Cox and Wilcox.

Industrial and Labour Notes

The National Coal Board and the Miners

The coal mines were formally transferred to the National Coal Board at a simple ceremony in London on January 1st. In the course of a speech on that occasion, the Minister of Fuel and Power, Mr. Shinwell, said that in recent weeks a level of output had been reached which, if maintained, would enable the remaining months of the winter to be faced with the assurance that supplies of coal for industry and other purposes would be reasonably adequate. If, however, the same level of output could not be maintained during the next few months, the task of those who had to implement the five-day week in the mines would be intensely difficult.

At the end of last week the National Union of Mineworkers issued a statement commenting on the new machinery for the settlement of disputes which was accepted by a national conference on December 20th. The statement said that the National Union had not given up the right to strike in return for the establishment of more expeditious methods of settling pit disputes. It was expected, however, that the speedier treatment of pit disputes, and a more understanding attitude on the part of the National Coal Board, would lead to a measure of satisfaction causing local and constitutional stoppages to disappear. The statement added that the National Union of Mineworkers was a completely free and independent body which was voluntarily co-operating with the National Coal Board in the biggest and most promising experiment in British industrial history.

The British Steel Industry

During last year the output of steel in the United Kingdom was affected to the extent of nearly 500,000 ingot tons on account of the coal shortage. It was stated early this week, however, that rapid conversion to oil firing is now being undertaken in suitable steel-producing areas, and that capacity using 400,000 tons of oil will be converted by the end of the present quarter. By the end of this year the steel industry expects to be using oil at the rate of 1,000,000 tons annually.

The British Iron and Steel Federation anticipates that the output of steel in 1947 should be between 13,000,000 and 13,500,000 ingot tons, compared with 12,690,000 ingot tons in 1946. Under favourable circumstances, 13,750,000 ingot tons could be produced this year, but if this is to be achieved adequate supplies of fuel, transport and scrap are essential. It is difficult to forecast imports, but it is hoped, nevertheless, that this country will receive 750,000 ingot tons of steel in 1947 from Dominion and other sources.

With regard to steel exports, only those declared essential by the Government will be permitted during 1947, and it seems likely that no more than 1,000,000 ingot tons will go abroad. As approximately 250,000 ingot tons of steel are still due to come from war stocks held by the Government, the total supply of steel available for home consumption this year should be between 13,000,000 and 13,500,000 ingot tons. The home demand for steel increased continuously in 1946, and during the last six months rose to an annual rate of 11,500,000 ingot tons.

From a long-term point of view, part of the present demand for steel must no doubt be regarded as temporary, although there is certain to be a permanent increase in the home demand. The steel industry is now engaged on the construction of new capacity which will enlarge production by 2,000,000 tons a year. In May, 1944, the British Iron and Steel Federation set up an Efficiency Committee to prepare the framework of a post-war modernisation programme, which was based on development schemes already approved by the Federation before the war. A natural hesitation on the part of the companies concerned to go ahead with their modernisation proposals interrupted progress in the early part of last year when the Government was considering the future of the iron and steel industry. The setting up of the Steel Board, however, enabled the industry to resume work on its plans, and in addition to the completion of a great deal of preparatory work, a large number of smaller, but none the less important, projects are now either well in hand or are in some cases being run in.

Collective Bargaining in the U.S.A.

The labour-management advisory committee of the United States Conciliation Service has recently expressed its support of the U.S. Government's present labour relations policy of free collective bargaining. At the same time, the committee has recommended the development of four mediation "techniques," which, it is suggested, may be useful in assisting management and labour to arrive at voluntary settlements of their own problems.

The suggestions made are that there should be appointed special conciliators—men known nationally for their work in labour relations—whose services would be available in major industrial disputes; tripartite mediation in some types of dispute, industry and labour representatives serving in an advisory capacity with the conciliator; the wider use of voluntary arbitration for dealing with grievances, and for resolving differences on new contract terms, when negotiation processes have been exhausted; and the use of emergency fact-finding boards in cases of national importance, where normal mediation efforts have failed.

The advisory committee, in its statement, expressed the view that any form of compulsory arbitration for the disposition of labour disputes might frustrate rather than foster industrial peace.

Business Visits to Germany

The Board of Trade stated a few days ago that arrangements have now been made to allow business men from this country to visit the British and American zones in Germany for commercial purposes. Owing to the limited transport and accommodation facilities, however, applications can only be considered from persons having a specific purchasing transaction in view.

In the first instance, applications should be made to the Sundry Materials Branch of the Board of Trade, 10, Old Jewry, London, E.C.2. They should be accompanied by firm inquiries for specific goods and the names of the German suppliers with whom applicants wish to deal should be stated. Evidence such as correspondence with German suppliers concerned, to show that they are in business and may be in a position to produce the goods required, should be included. Applications should also give reasons why a visit to Germany is regarded as desirable.

Imports from Germany to this country will continue to be handled by the Sundry Materials Branch of the Board of Trade.

L.N.E.R. Stratford Works Dispute

For the past month many suburban train services from Liverpool Street and Fenchurch Street on the London and North-Eastern Railway have had to be cancelled owing to a shortage of locomotive power. The shortage has been brought about by a dispute between the L.N.E.R. and mechanics at the Stratford locomotive depot who have been "working to rule."

In a statement issued on Saturday last, the L.N.E.R. has reviewed the events leading to the present situation. On November 7th last a local claim was submitted by the Stratford depot that certain of the workshop staff employed there should be paid the average earnings of the staff in the main production shops. A section of the staff dissociated itself from this application on the grounds that a local claim was not in order, and that the question of increased payments to the whole of the workshop staff should be put to the headquarters of the trade unions concerned for negotiating with the company. On November 18th the staff representatives at the Stratford depot were given a reply that the application for payments additional to time rates raised very wide issues, requiring careful investigation, and that it was not possible to give a definite reply until the matter had been thoroughly examined. The men are, meanwhile, being paid in accordance with the national agreements between the railway companies and the unions. On November 22nd the shop staff representatives handed the company's local official a communication which stated that in view of the unsatisfactory reply, an embargo on all overtime, including Sunday duty, by the men covered by the application would be imposed on and from November 25th. It was also stated that the men would "work to rule."

On November 26th the chief general manager of the L.N.E.R. wrote to the headquarters of the Amalgamated Engineering Union reiterating that the men's application was receiving consideration, and asking the A.E.U. to take the necessary steps to ensure normal working at Stratford. The L.N.E.R. wrote again to the union on December 4th, and on December 9th received a reply stating that the A.E.U. was awaiting the observations of its London district secretary who was investigating the matter. Further correspondence and telephone conversations took place between the L.N.E.R. and the union in the hope that normal working might be restored, and ultimately the A.E.U. stated that the matter would be considered by its executive council on December 23rd. The company was not advised of the result of this meeting. On December 31st an official of the A.E.U. communicated with the L.N.E.R. and, at the company's suggestion, a discussion took place on January 1st. At this meeting the serious situation which had arisen as a result of the men's irregular action was impressed upon the A.E.U. representative, as well as the immediate necessity for bringing about a resumption of normal working. The A.E.U. representative undertook to meet the men at Stratford as quickly as possible, and it was understood that this approach was in furtherance of steps which the A.E.U. had already indicated that it was taking to bring about a resumption of normal working.

Labour Needs in the U.S.A.

In his Message on the State of the Union to the United States Congress on Monday last, President Truman stated that his Government's policy regarding labour was still based on the principle of collective bargaining. He went on to outline a four-point labour programme which he proposed, and in which he suggested the early enactment of legislation to outlaw jurisdictional strikes and the use of economic force by labour or management to decide issues arising out of the interpretation of existing contracts. Mr. Truman urged that there should be legislation to provide machinery whereby unsettled disputes concerning the interpretation of existing agreements could be referred by either party to final and binding arbitration.

Other proposals in the President's programme are the extension of facilities within the Department of Labour for assisting collective bargaining; the broadening of the national programme of social legislation to alleviate the causes of insecurity amongst workers; and the appointment of a temporary joint commission by Congress to inquire into the entire field of labour-management relations. With regard to this last point, the President said that on the proper solution of the labour-management problem depended the whole industrial future of the U.S.A., for the paralysing effect of nation-wide strikes could result in national disaster. In recent years such disaster had been avoided by the use of extraordinary war powers, but now that those powers would soon be gone, an adequate system and effective machinery must be created.

French Engineering News

(From our French Correspondent)

PARIS, January 3rd.

The programme for the renovation and reconstruction of the S.N.C.F. is to seek a happy medium between the pre-war over-abundance of passenger trains and the drastic war-time reductions which brought the number of passengers carried in a train from 77 in 1938 to 510 in 1943. New light carriages will enable the passenger capacity to be increased, speed will be increased to 140 km an hour, and even higher on some routes. Comfort will be improved, particularly in the 3rd class, and sleeping accommodation increased.

The goods services will be speeded and rationalised so as to reduce transport costs. Tonnage will be increased and direct liaisons between goods yards multiplied. Finally, important simplifications will be introduced in tariffs.

Important track and signal installations are included in the programme. 9435 kilometres of track will be fitted with 50 kilo rails, which can take 23-ton axles. The speed limit will increase to 140 kilometres an hour. 14,430 kilometres of track will have 46 kilogram rails, taking 20-ton axles. Altogether the work will take 12 years, but the greater part will be finished in 10 years. Various lines will be doubled and even quadrupled.

Automatic illuminated signal installations now in use over 2800 kilometres will be extended to 5300. Passenger facilities will be improved as stations are reconstructed.

Accelerated goods services will include the installation of about 100 centres, linked to each other by fast goods trains. The three large goods depots in the Paris region will be linked by a small and large ring service. Large goods depots with the most modern equipment are envisaged. Primary depots will be linked by direct trains, which will reduce delays and risks, as well as expenses. The programme also envisages a large-scale concentration of railway workshops. Tools and machinery in these shops will be almost entirely renewed.

In spite of recent difficulties, the S.N.C.F. has received a good part of the material ordered from the United States. Out of 1200 "141R," locomotives 960 have been delivered, of which 34 are equipped with fuel oil. Out of 100 Baldwin diesel electric locomotives, of 660 h.p., 42 have been delivered. 36,750 goods trucks, including 10,000 tipping and 26,750 covered trucks have been ordered in units for assembly in France, and if present rate of delivery is kept up, by February, 1947, 200 a day will be assembled. Out of the 150,000 tons of rails ordered, 55,000 have been delivered, as well as almost all the steel (40,000 tons) ordered. In addition, the United States will supply France with material for temporary bridges, machinery for reconstruction, lorries and divers mechanical necessities, such as bull-dozers.

There has also been considerable recovery of material from Germany. Out of the 3000 locomotives taken, 1710 have been restored; 3500 out of the 8000 passenger coaches and 60,000 out of the 275,000 trucks have been recovered, as well as 40 out of 60 railcars.

* * *

It has been estimated that owing to shortage of metallurgical coke, the steel industry lost 200 milliard francs worth of business in 1946. Altogether, the monthly average consumption in 1929 was 1,580,000 tons. In May, 1946, consumption was 448,000 tons. In April, 1946, out of 171 blast-furnaces capable of producing iron, only 30 were working. To-day there are 37. Out of the 109 Martin steel plants, in April only 35 were working; to-day there are 45. The extent to which these plants can be restarted depends almost entirely on coke allocations, and at the moment a plant possessing 5 or 6 blast-furnaces can only run one. In 1929, 304,000 tons of Ruhr coke were sent to France per month. In July, 1946, Germany sent 35,000 tons. Since coke only accounts for 10 per cent of the price of steel or steel products, it is urged that it should be sought anywhere and at any price.

Notes and Memoranda

Rail and Road

G.W.R. PORTHCAWL BRANCH.—A contract has been placed by the Great Western Railway for the doubling of about 1¼ miles of the north end of the Porthcawl branch. The work consists mainly of the widening of two small bridges and the removal of about 11,000 cubic yards of rock and a similar quantity of soft material in cuttings. The lay-out of the doubling is such as will allow for an improvement of the existing track alignment.

L.M.S. HOSTELS-ON-WHEELS.—In order to relieve the difficulty of obtaining houses or lodgings for railway workers, which is accentuating its labour difficulties in the London area particularly, the London, Midland and Scottish Railway is converting a fleet of pre-war caravan camping coaches into living trains for permanent way staff. Conversion of the camping coaches is now in progress at the L.M.S. carriage works at Wolverton, Bucks, and, when completed, will provide eight living trains with aggregate accommodation for 160 men. The trains will be stabled at convenient sidings in Outer London and the Home Counties. Each train will accommodate twenty men and will consist of three coaches, two of which will be dormitory coaches, each sleeping ten men. The third coach in each train will have a self-contained kitchen and two living rooms with padded seats, and provision for reading, writing and games.

Air and Water

THE LIFEBOAT SERVICE.—Last year was the busiest that the British lifeboat service has ever had in time of peace. Lifeboats were launched over 620 times, and they rescued nearly 600 lives. Ten new motor lifeboats were laid down of the eighty which the Royal National Life-boat Institution hopes to build in the next few years at a cost of a million pounds.

NEW AERODROME FOR STOCKHOLM.—The Swedish Government has asked the Riksdag for appropriations for the building of a new aerodrome by Lake Halmsjön, north of Stockholm. It is intended to be the terminus of the Scandinavian airlines to the U.S.A., and for future lines to South America, India, China, and elsewhere. The estimated cost of the new aerodrome is stated to be over £5,000,000, and its construction will take five years.

NEW DESTROYER FOR SWEDISH NAVY.—A second Swedish destroyer of the "Province" class was recently launched at the Karlskrona Naval Shipyard. The new destroyer, which is of 1800 tons, was named "Uppland." Including the "Uppland" and her sister ship "Oland," which was launched about a year ago, the Swedish destroyer fleet now comprises twenty-three modern ships, thirteen of which have been built since 1939.

TOLEDO WATER-RAIL TERMINAL.—Construction is proceeding on a dock which will provide a new water-rail terminal for Toledo, Ohio. The cost of the undertaking is estimated at 18 million dollars. The terminal is on the south shore of Maumee Bay, 6 miles from Toledo, and facilities will be given for loading coal into ships and unloading iron ore from the lake steamers. The project is being undertaken jointly by the Baltimore and Ohio and the New York Central Railroads. Work started last June and, according to *Engineering News-Record*, the terminal is scheduled for completion early in 1948.

Miscellanea

MACHINE TOOL AUCTION SALE.—The Ministry of Supply announces that a two-days' auction sale of machine tools will be held at the M.O.S. Depot, Queens Road, Kilmarnock, Ayrshire, on Tuesday and Wednesday, January 28 and 29, 1947, beginning each day at 11 a.m. Among the machine tools to be offered are plain and vertical milling machines, cylindrical grinders, profiling machines, turret and capstan lathes, circular sawing machines, thread millers and centring machines.

CORRECTION.—In the description of the "Pneu Mech" dust collecting plant of the J. S. Engineering Company, Ltd., in our issue of December 20, 1946, the main valve was inadvertently referred to as the main contaminated air inlet valve. The sentence describing the mechanism of the plant should have read: "For this purpose the firm has developed an interesting mechanism for closing the main cleaned air exit valve and opening the reversed-flow scavenging valve in each chamber in turn." It should be noted that the cleaning cycle is arranged so that only one chamber is out of commission in a given period.

PHYSICAL SOCIETY EXHIBITION.—The Physical Society has planned to hold the thirty-first Exhibition of Scientific Instruments and Industrial Apparatus from April 9th to 12th inclusive, in the Physics and Chemistry Departments of Imperial College, South Kensington, London, S.W.7. Tickets will be obtainable early in March from Fellows of the Society and from exhibiting firms.

TUNGSTEN ORE.—The Ministry of Supply announces that as from January 1st the issue price of tungsten ore of standard grade has been increased from 70s. to 75s. per unit of WO_3 delivered consumers' works. For special high-grade scheelite to the following specification: WO_3 minimum 68 per cent, tin maximum 0·60 per cent, arsenic maximum 0·10 per cent, molybdenum maximum 0·10 per cent, the price is now 80s. per unit WO_3 delivered consumers' works.

SWEDEN'S HYDRO-ELECTRIC POWER.—A report on fuel economy since 1939, prepared by the Swedish National Committee of the World Power Conference, says that the output of hydro-electric energy in Sweden in 1939 was 8,125,000 kWh, corresponding to about 1200 kWh per inhabitant. In 1945 the output had risen to 13,100,000 kWh, or about 2000 kWh per inhabitant. On account of transmission losses, the corresponding consumption of hydro-electric energy in 1939 and 1945 was about 13 and 15 per cent lower than the respective outputs of those years. It has been calculated that the increased consumption of hydro-electric energy has reduced the annual pre-war fuel consumption of the country by an equivalent of 750,000 tons of coal.

ROYAL EASTER SHOW, SYDNEY, 1947.—To mark the post-war resumption of the Royal Easter Show at Sydney, the Royal Agricultural Society of New South Wales has decided to devote the Commemorative Pavilion to an Empire Exhibition, to which the Governments of the United Kingdom, the Dominions and Colonies have been invited to contribute sections. On behalf of the United Kingdom, the Board of Trade has accepted space for the demonstration of the achievements of this country in technique and design during the past few years. The exhibits have been chosen to interest the general public in Australia rather than the technician; they will illustrate, for example, the use of new materials, such as plastics, for a very wide range of familiar articles, improved methods of domestic heating and the high standard of precision and realism in British post-war toys. Many new designs for consumer goods drawn from the "Britain Can Make It" Exhibition will be included, and another outstanding exhibit will be a Rolls-Royce "Nene" jet engine.

COPPER, LEAD AND ZINC.—The Minister of Supply has made the Control of Non-Ferrous Metals (No. 26) (Copper, Lead and Zinc) Order, 1946, which came into force on January 1, 1947. This Order increases maximum prices as follows:—Copper, by £19 per ton; lead, by £15 per ton; zinc, by £15 per ton; zinc sheets, by £15 per ton; and zinc oxide, by £12 15s. per ton. The price of high-conductivity electro copper has therefore been increased from £98 to £117 per ton; of good soft pig lead (Empire and domestic) from £55 to £70 per ton; and of zinc (g.o.b. domestic and prime western) from £55 to £70 per ton. Prices for other forms of these metals have been correspondingly adjusted. The price of zinc sheets has been increased from £66 2s. 6d. to £81 2s. 6d. per ton ex works, and for red seal zinc oxide from £56 to £68 15s. per ton delivered with a similar increase for the other forms of zinc oxide. Holders of outstanding licences granted on or before December 31, 1946, will only be covered at the new prices now in force. The new Order also releases hot-rolled copper wire rods from acquisition and disposal licensing.

Calendars and Diaries

We acknowledge the receipt of calendars and diaries for 1947 from the undermentioned firms:—

HARLAND AND WOLFF, Ltd., Belfast.

HOLMAN BROTHERS, Ltd., Camborne.

RUSTON AND HORNSBY, Ltd., Lincoln.

BROOKHIRST SWITCHGEAR, Ltd., Chester.

LONDEX LTD., 207, Anerley Road, S.E.20.

D. NAPIER AND SON, Ltd., 211, The Vale, Acton, W.3.

GEAR GRINDING COMPANY, Ltd., Shirley, Birmingham.

J. SAMUEL WHITE AND CO., Ltd., Cowes, Isle of Wight.

EDWARD WOOD AND CO., Ltd., 68, Victoria Street, S.W.1.

ASSOCIATED EQUIPMENT COMPANY, Ltd., Southall, Middlesex.

BRITISH VACUUM CLEANER AND ENGINEERING COMPANY, Ltd., Leatherhead, Surrey.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Tuesday, Jan. 21st.—Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Delicolor Equipment," E. E Faraday. 6.15 p.m.

Bradford Engineering Society

Monday, Jan. 20th.—Technical College, Bradford. "Valve Design," E. A. B. Greaves. 7.15 p.m.

Derby Society of Engineers

Monday, Jan. 13th.—School of Arts, Green Lane, Derby. "Industrial Electronics," P. Bowles. 7 p.m.

Diesel Engine Users Association

Thursday, Jan. 16th.—Caxton Hall, Westminster, S.W.1. "Recent Developments in Heavy Oil Engine Lubrication," R. A. Collacott. 2.30 p.m.

Illuminating Engineering Society

Tuesday, Jan. 14th.—E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Colour in Illuminating Engineering," W. D. Wright. 6 p.m.

Institute of Marine Engineers

Tuesday, Jan. 14th.—85, The Minories, E.C.3. "The Phosphate Treatment of Wearing Parts of Machinery," R. E. Shaw. 5.30 p.m.—BELFAST JUNIOR SECTION: College of Technology, Belfast. "The Launching of Ships," Denis Rebbeck. 7.30 p.m.

Monday, Jan. 20th.—JUNIOR SECTION: University of London, King's College, Strand, W.C.2. "Gas Turbines and their Prospects," S. J. Davies. 6 p.m.

Institute of Physics

Friday, Jan. 17th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. "Sonic Methods in Non-Destructive Testing," R. Meakin. 6.30 p.m.

Institute of Refrigeration

Tuesday, Jan. 14th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "Small Hermetically Sealed Type Compressors," E. G. Rowledge. 5.30 p.m.

Institute of Welding

Wednesday, Jan. 15th.—N. LONDON BRANCH: Fyvie Hall, Polytechnic, Regent Street, W.1. "The Application of Welding to Steel Structures," R. G. Braithwaite. 7.30 p.m.

Saturday, Jan. 18th.—W. SCOTLAND BRANCH: North British Station Hotel, George Square, Glasgow. Annual luncheon. 1 p.m.

Institution of Automobile Engineers

Tuesday, Jan. 14th.—COVENTRY BRANCH: Geisha Café, Hertford Street, Coventry. "Structural Problems of the Commercial Vehicle," V. W. Pilkington. 7 p.m.—LUTON GRADUATES: Technical College, Luton. "Power Unit Bench Testing," D. Q. Martin. 7.15 p.m.

Thursday, Jan. 16th.—BRISTOL BRANCH: Grand Hotel, Bristol. "Some Problems of Cylinder Bore Wear," W. A. Robotham. 6.45 p.m.

Wednesday, Jan. 22nd.—12, Hobart Place, S.W.1. "Twin-Piston, Two-Stroke Engine Design," J. Ehrlich. 6.30 p.m.

Institution of British Agricultural Engineers

Tuesday, Jan. 14th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "The Mechanical Requirements of the Small Grower and Horticulturist," A. P. Bevan. 2 p.m.

Institution of Civil Engineers

Tuesday, Jan. 14th.—S. WALES AND MONMOUTHSHIRE ASSOCIATION: S. Wales Institute of Engineers, Park Place, Cardiff. "Demolitions in N.W. Europe," Lieut.-Colonel A. Borlaise. 6 p.m.

Institution of Electrical Engineers

Monday, Jan. 13th.—N. EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle-on-Tyne. "The Influence of Resistance Switching on the Design of High-Voltage Oil Circuit Breakers," H. E. Cox and T. W. Wilcox. 6.15 p.m.

Tuesday, Jan. 14th.—SCOTTISH CENTRE: Royal Technical College, George Street, Glasgow. "Fundamental Legislation for Electricity Supply to Consumers," W. Fennell. 6.15 p.m.—N. MIDLAND CENTRE: Corporation Electricity Department, Whitehall Road, Leeds. "Silicon Carbide Non-ohmic Resistors," F. Ashworth, W. Needham and R. W. Sillars. 6 p.m.

Saturday, Jan. 18th.—N. MIDLAND STUDENTS: Corporation Electricity Department, Whitehall Road, Leeds. Chairman's Address, A. G. Connell. 2.30 p.m.

Tuesday, Jan. 21st.—N. WESTERN CENTRE (TRANSMISSION GROUP): Engineers' Club, Albert Square, Manchester. "Three-Phase Distribution and Electric Welding and Furnace Loads," A. Langley Morris. 6 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Jan. 21st.—39, Elmbank Crescent, Glasgow. "Longitudinal Bending Moments in Ships," J. M. Murray.

Institution of Heating and Ventilating Engineers

Monday, Jan. 13th.— MANCHESTER BRANCH: Milton Hall, Deansgate, Manchester. "Unit Heaters," H. Y. Turnbull and H. Hoyle. 7 p.m.

Institution of Locomotive Engineers

Wednesday, Jan. 15th.—Inst of Mechanical Engineers, Storey's Gate, S.W.1. "Organisation and Carrying Out of Examinations and Repairs of Locomotives at Running Sheds, in Relationship to Locomotive Performance and Availability," Lieut.-Colonel Harold Rudgard. 5.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 10th.—Storey's Gate, St. James's Park, S.W.1. "The Development of an Axial-Flow Gas Turbine for Jet Propulsion," D. M. Smith; "Practical Aspects of Cascade Wind Tunnel Research," K. W. Todd. 5.30 p.m.

Monday, Jan. 13th.—MIDLAND GRADUATES: Victoria Hotel, Wolverhampton. "Some Aspects of the Development of Machine Tools," D. A. Trafford 7.30 p.m. (Joint meeting.)

Friday, Jan. 17th.—Storey's Gate, St. James's Park, S.W.1. "Recent Developments in Flying-Boats," H. Knowler. 5.30 p.m.

Monday, Jan. 20th.—MIDLAND GRADUATES: James Watt Memorial Institute, Great Charles Street, Birmingham. Chairman's Address, "Making the Modern Motor Tyre," H. Devey. 7 p.m.

Friday, Jan. 24th.—Storey's Gate, St. James's Park, S.W.1. "Materials New to Engineering," F. T. Barwell. 5.30 p.m.

Institution of Mining and Metallurgy

Thursday, Jan. 16th.—Geological Society, Burlington House, Piccadilly, W.1. "The Development of Metallurgical Practice for the Treatment of Nchanga Mixed Oxide-Sulphide Ores," H. L. Talbot. 5 p.m.

Institution of Post Office Electrical Engineers

Wednesday, Jan. 22nd.—Faraday Building (9th Floor), Knightrider Street, E.C.4. "Auto Exchange Maintenance," A. Hudson, E. A. Smith and F. S. Hyatt. 5 p.m.

Institution of Production Engineers

To-day, Jan. 10th.—N. EASTERN GRADUATES: Neville Hall Mining Institution, Newcastle-on-Tyne. "Elementary Principles of Cutting Tool Design," T. Burton. 6.30 p.m.

Tuesday, Jan. 14th.—BIRMINGHAM GRADUATES: James Watt Memorial Institute, Great Charles Street, Birmingham. "The Manufacture of Optical Glass," R. E. Bastick. 7.15 p.m.

Wednesday, Jan. 15th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham. "Management in Action," W. C. Puckey. 7 p.m.

Thursday, Jan. 16th.—LEICESTER SECTION: College of Technology, Leicester. "Line Production of Footwear," E. Eatough. 7 p.m.—GLASGOW SECTION: Inst. of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. "Measurement of Surface Finish," C. Timms. 7.30 p.m.

Friday, Jan. 17th.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol. "Crushing Wheels for Form Grinding," G. H. Ashbridge. 6.45 p.m.

Monday, Jan. 20th.—N. EASTERN SECTION: Neville Hall Mining Institution, Newcastle-on-Tyne. "Profile Machining," N. J. Cooke; "Preventive Maintenance of Machine Tools," F. Ward. 6.30 p.m.—DERBY SUB-SECTION: Art School, Green Lane, Derby. "Hydraulics as Applied to Machine Tools," W. Whitworth Taylor. 6.45 p.m.

Wednesday, Jan. 22nd.—PRESTON SECTION: Harris Institute, Avenham, Preston. "The Training of Apprentices," V. W. Pilkington. 7.15 p.m.—MANCHESTER SECTION: College of Technology, Manchester. "Factory Inspection," H. E. Chastney. 7.15 p.m.

Institution of Sanitary Engineers

Friday, Jan. 17th.—Caxton Hall, Westminster, S.W.1. "The Metropolitan Water Board," H. Berry. 6 p.m.

Institution of Structural Engineers

Thursday, Jan. 23rd.—11, Upper Belgrave Street, S.W.1. "The Stress Grading of Timber and its Influence on Structural Design," E. H. Nevard. 6 p.m.

Newcomen Society

Wednesday, Jan. 22nd.—MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "History of the Staffordshire Thick Coal Seam," F. T. Perrins. 5.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Jan. 17th.—Mining Institute, Newcastle-on-Tyne. "Application of Modern Management Methods to the Shipbuilding Industry," F. A. J. Hodges. 6 p.m.

Royal Aeronautical Society

Thursday, Jan. 16th.—Inst. of Civil Engineers, Great George Street, S.W.1. Film, "In Occupied Japan." 6.30 p.m.

Royal Society of Arts

Wednesday, Jan. 22nd.—John Adam Street, Adelphi, W.C.2. "Gas Turbines," Sir Claude Gibb. 5 p.m.

Rugby Engineering Society

Wednesday, Jan. 15th.—Corporation Electricity Department, Rugby. "An Outline of the Relaxation Method, with Illustrations from Recent Developments," D. N. de G. Allen. 7.30 p.m.

Sheffield Society of Engineers and Metallurgists

Monday, Jan. 20th.—Royal Victoria Station Hotel, Sheffield. "Recent Developments in the Aluminium Industry," C. J. Smithells. 6.15 p.m.

Society of Instrument Technology

To-day, Jan. 10th.—SCOTTISH SECTION: Royal Technical College, Glasgow. "Humidity," A. Lees. 7 p.m.—MIDLAND SECTION: Chamber of Commerce Building, New Street, Birmingham. "Electronic Instruments," D. Edmundson. 7 p.m.

Stephenson Locomotive Society

Saturday, Jan. 11th.—LEEDS BRANCH: Y.M.C.A., Albion Place, Leeds. "Some Railway Journeys," A. E. Robinson. 2.30 p.m.

Saturday, Jan. 18th.—MANCHESTER BRANCH: Manchester Geographical Society Rooms, St. Mary's Parsonage, Manchester. "Webb Compound Locomotives of the L.N.E.R.," B. Baxter. 6.15 p.m.

Personal and Business

MR. G. K. FRANKLIN has been appointed export sales manager of Catalin, Ltd.

MR. B. G. W. ATTWOOD has been appointed a director of the Plessey Company, Ltd.

MR. J. W. L. SIMPSON has been appointed general manager of Robert Cort and Son, Ltd.

LORD LATHAM has been re-appointed a member of the London Passenger Transport Board.

THE VALOR COMPANY, Ltd., is opening a branch factory at Chapelhall, near Airdrie, Scotland.

MR. R. B. PORTER has been appointed chief assistant engineer of the Tyne Improvement Commission.

MR. A. H. TOMS has been appointed research assistant in the chief civil engineer's department, Southern Railway.

THE ALUMINIUM DEVELOPMENT ASSOCIATION has moved to 33, Grosvenor Street, London, W.1 (telephone, Mayfair 7501).

DUNLOP LTD. announces the appointment of Mr. H. J. Holmes as regional manager for the West of England, with headquarters at Bristol.

THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION has changed its address to Kingsway House, 103, Kingsway, W.C.2.

FISHER AND LUDLOW, Ltd., has changed its address to Albion Works, Kingsbury Road, Erdington, Birmingham, 24 (telephone, Erdington 2141).

MR. J. CAMPBELL, Mr. W. D. K. Marshall, Mr. E. D. Russell and Mr. F. R. Topping have been appointed directors of William Denny and Brothers, Ltd., Dumbarton.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS has established a branch office at Janmabhoomi Chambers, Fort Street, Ballard Estate, Bombay, India.

MESSRS. MERZ AND MCLELLAN have taken into partnership Mr. Frederick C. Winfield, who has been a member of their staff for many years. Mr. Winfield will normally be at the firm's Newcastle office.

COLVILLES LTD. announces that Mr. W. Barr, Mr. R. C. Dymock, Mr. T. W. Hand, Mr. J. M'Cracken, Mr. R. Marshall, Mr. L. Rothera and Mr. T. J. Smith have been appointed executive directors.

RICHARD C. GIBBINS AND CO., Ltd., announces the following appointments:—Mr. W. L. Allan, director and works manager; Mr. G. N. Whitehouse, director and commercial manager; Mr. S. T. Locke chief designer.

THE COLONIAL OFFICE announces the following appointments:—Mr. Gordon Wallwork, an assistant engineer, Tanganyika Railways; and Mr. Leslie Ponsford, assistant engineer, Public Works Department, Nyasaland.

CAPTAIN E. M. COATES has been appointed marine superintendent of the P. and O. and British India companies in succession to Captain E. P. Lynden who has now retired. Captain A. Rodger has been appointed assistant marine superintendent.

THE MINISTER OF TRANSPORT has appointed Sir Archibald McKinstry, D.Sc., M.I. Mech. E., M.I.E.E., to be the second member of the Road and Rail Appeal Tribunal constituted under the Road and Rail Traffic Act, 1933, for a period of three years, with effect from January 1st.

FELLOWSHIPS of the City and Guilds of London Institute (F.C.G.I.) have been conferred upon Mr. Harold Bishop, M.I. Mech. E., M.I.E.E., Mr. Loughnan St. L. Pendred, M.I. Mech. E., M.I. and S. Inst., Mr. C. E. R. Sams, M.I. Mech. E., Major-General A. W. Sproull, M.I. Mech. E., M.I.E.E., and Sir Bruce G. White, M. Inst. C.E., M.I. Mech. E.

MR. S. B. HASLAM has relinquished the South Wales agency of Ferodo, Ltd., and all inquiries should now be addressed to the firm's depot at 60, Charles Street, Cardiff. Ferodo, Ltd., announces also that Mr. C. Creswick has relinquished the Yorkshire and Nottinghamshire agency. Inquiries from this area should be sent to the head office at Chapel-en-le-Frith.

BABCOCK AND WILCOX, Ltd., announces the following appointments:—Mr. H. McNeil, general manager; Mr. W. F. C. Schaap, deputy chief engineer, retaining the position of chief project engineer; Mr. C. H. Davy, chief research and development engineer; and Mr. T. W. Pollock, chief technical engineer, Renfrew works, in succession to Mr. E. G. Weeks, who has retired.

THE LONDON, MIDLAND AND SCOTTISH RAILWAY COMPANY announces the following appointments:—Mr. J. Davidson, district locomotive superintendent, St. Rollox; Mr. A. C. Jeffrey, district locomotive superintendent, Inverness; Mr. G. Luttrell, assistant district locomotive superintendent, Carlisle; and Mr. J. Chalmers, assistant district locomotive superintendent, Perth.

A Seven-Day Journal

Coal Supplies to Industry

On Monday last, the President of the Board of Trade, Sir Stafford Cripps, and the Minister of Fuel and Power, Mr. Shinwell, announced new plans for supplying coal to industry. These plans have been formulated after reviewing the amount of coal likely to be available during the next six critical weeks of the winter period. Sir Stafford said that, at present, the weekly coal consumption could be classified as follows:—Gas undertakings, 530,000 tons; electricity undertakings, 650,000 tons; industrial and domestic coke ovens, 400,000 tons; iron and steel industry, 200,000 tons; other industries, 800,000 tons; railways, 300,000 tons; and domestic use, 600,000 tons. As gas, electricity, railway and domestic supplies would not be reduced, the consumption figure on which further savings were possible was 1,150,000 tons a week. Starting from Monday next, January 20th, new allocations are to be made to industry on what Sir Stafford described as a realistic basis. In some industries cuts up to 50 per cent of prior allocations may be made, although this does not mean that firms will receive only half their earlier deliveries, as in many cases actual deliveries have not amounted to more than 55 per cent of allocations. Sir Stafford explained that actual coal supplies would be about 87 per cent of those received in November, and there would be additional supplies to firms considered to be of national importance. The amount in each case is to be decided by the Regional Fuel Allocation Committees, and the undertakings qualifying for such extra supplies are to be notified as soon as possible. Electricity and gas undertakings are not to have their coal supplies reduced, and, according to Mr. Shinwell, will, in fact, be getting more coal than ever before.

Federation of British Industries

At a meeting of the Grand Council of the Federation of British Industries, which was held on Wednesday, January 8th, Sir Frederick Bain, M.C., the Deputy President of the F.B.I., was nominated President of the Federation. The nomination, which was unanimously approved, will come before the annual general meeting of the Federation, which will take place in April, when Sir Clive Baillieu, K.B.E., C.M.G., will retire from the presidency, having held office for two years. Sir Frederick Bain, a deputy chairman of Imperial Chemical Industries, Ltd., was, we may recall, appointed Deputy President of the Federation in February last. From 1941 to 1944 Sir Frederick was Chairman of the Chemical Control Board of the Ministry of Supply, and was Chairman of the Chemical Planning Committee of the Ministry of Production. During the 1914–18 war Sir Frederick served as a Captain in the 4th Gordon Highlanders, and gained his M.C. From 1916 to 1918 he was Deputy Director of Chemical Warfare Supply at the Ministry of Munitions.

Reconstruction of Queen's Dock, Glasgow

At a meeting of the Clyde Navigation Trustees, which took place in Glasgow last week, a reconstruction programme, costing £6,275,000, which will probably require eight years to complete, was approved for the Queen's Dock, with the object of making it suitable for the berthing of large ships. The dock, which was built in 1880, is near the heart of the city, and when the work is finished it will give to deep-draughted ships, accommodation and berthage greater in extent than the King George V Dock, which is looked upon as the most modern in the Glasgow system. The reconstruction plan will need authority, and the Trustees will require to promote a provisional order. The new scheme includes commodious sheds and a greatly improved railway system throughout the dock. A depth of about 32ft at low water at the thirteen ocean berths will be provided, compared with a present draught of 18ft to 20ft. Other important provisions provide for the demolition of the existing central pier, reaching 1900ft into the dock and the removal of the swing bridge which spans the entrance. The dock entrance will be widened from 100ft to 295ft, and in the river channel where it is joined by the Prince's Dock and the Queen's Dock, canting space will be given for all vessels up to 600ft in length, while on the north side of the river at Stobcross the berthage will be improved. The scheme will also have the effect of merging Queen's Dock with Yorkhill Quay, which is now used by liners operating on the North Atlantic route. In carrying out this important scheme of reconstruction the work will so be arranged that as each section of dock is completed it will become available for service.

Proposed International Exhibition, 1951

The Royal Society of Arts has sent invitations to 165 organisations in Great Britain to a conference to discuss whether an International Exhibition on a large scale should be held in London in the near future. The conference will be held at the Society's house, John Adam Street, Adelphi, W.C.2, at 11 a.m. on Thursday, February 6th. It may be recalled that the Royal Society of Arts—formerly the Society of Arts—took the initiative in promoting the International Exhibition in Hyde Park in 1851, and has recently joined in advocating the holding of another and far greater exhibition in 1951 to mark the centenary. In 1945 the Ramsden Committee made a strong recommendation in favour of such an exhibition, and early last year the Government accepted the recommendation. The matter is at present in suspense, however, as the Government is understood to be averse from the use of Hyde Park as a site, as it feels that public opinion would not be likely to approve it. Moreover, it considers that any other site of sufficient size would have to be sought outside Central London, and that any exhibition on a large scale would involve a demand for labour and materials which could not be met as early as 1951. The Royal Society of Arts feels, nevertheless, that considerations can be put forward in reply, and the conference, as well as discussing whether an International Exhibition should be held, will deliberate as to whether Hyde Park should be the site, and whether efforts should be made to hold it in 1951. Should the conference approve a general proposal, the intention is to make a formal approach to the London local authorities and to the Government.

The Partial Census of Production

The Board of Trade is now issuing the appropriate forms to the engineering industry for making the Partial Census of Production relating to the year 1946. The Engineering Industries Association stated at the beginning of the week that complaints being received from member-firms all refer to the immense amount of statistical research required to complete the forms, a task occupying the attention of works executives to the positive detriment of production. The Council of the E.I.A. has give consideration to the matter, and has resolved that the Association's views should be clearly represented by Members of Parliament on both sides when the committee stage of the Statistics of Trade Bill is reached in the House of Commons. By this means the Association hopes that the Bill may at least be made a practical proposition, and it is also hoped to prevent the present form, or one as burdensome, being annually circulated to every industrial concern in the country. Meanwhile, the Association advises member-firms which have received the form to apply for the duplicate form mentioned in paragraph 7 of the cover page; to ask for the assistance offered by the Board of Trade in completing the form; and to send to the headquarters of the E.I.A. copies of any letters they address to the Census of Production Office and copies of any replies received. A meeting of the London members of the Association was held on Wednesday, January 15th. It was addressed by Mr. H. Leak, Director of Statistics at the Board of Trade, whose department is directly responsible for the compilation of the census form now being circulated.

Generation of Electricity

In twelve months the output of electricity generated by authorised undertakers in Great Britain has increased by nearly 19 per cent. A recent statement by the Electricity Commission shows that authorised undertakers generated 4372 million units of electricity during the month of December, 1946, representing an increase of 693 million units, or 18·8 per cent above the revised figure of 3679 million units for the corresponding month of 1945. During the year 1946 the total number of units generated by authorised undertakers was 41,240 million units, as compared with the revised figure of 37,287 million units for the year 1945, representing an increase of 3953 million units, or 10·6 per cent. The total number of units sent out from the generating stations of authorised undertakers during the month of December, 1946 (*i.e.*, units generated less units consumed in the stations by auxiliary plant and for lighting, &c.) was 4140 million units. The total number of units sent out from these generating stations during 1946 was 38,922 million units.

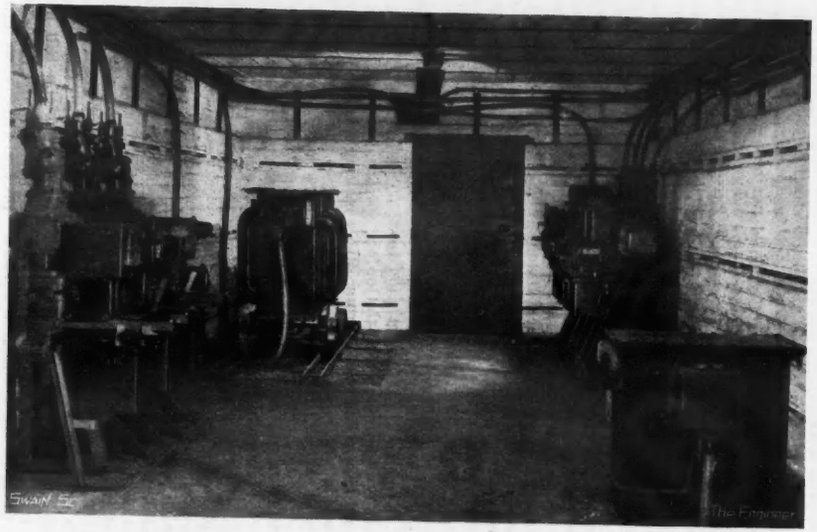
A New Town at Crawley

On Friday, January 10th, the Crawley New Town (Designation) Order, 1947, was published in *The London Gazette* and the statutory notice that the Order has been made by the Minister of Town and Country Planning was served on the authorities. In an accompanying statement the Minister refers to the objections raised by interested local authorities and private individuals affected by the proposals at the public local inquiry held from November 4 to 6, 1946, and deals with the main objections raised. He holds that a new town at Crawley is necessary, and sees no difficulty in maintaining an adequate belt of open country between the new town and adjoining built-up areas. With regard to the nearness of Crawley to London and its excellent railway connections, the Minister is of the opinion that it will be feasible for the development of the new town to be so ordered that it will become largely self-contained. As to the site being too flat and the soil water-logged, the Minister is advised that the area is suitable for building development, and that an adequate system of drainage for all purposes can be provided. The present by-pass road is to be diverted east or west of the new town, and the existing Crawley by-pass will be used for local traffic. With regard to railway arrangements, the Minister is satisfied that a satisfactory system of intercommunication within the town can be provided without undue difficulty or expense. Gatwick airport is likely to be used for charter and private flying, and the proximity of such an airfield to the new town is looked upon as a definite advantage. The Ministry and the Ministry of Health have examined the question of water supply, and the Minister is advised that no great engineering difficulties are anticipated in the provision of an adequate supply of water for the new town at a reasonable cost. Sewage and surface water disposal problems have also been examined by the same Ministries, and no great difficulties are expected. The inclusion of land in Surrey is considered necessary for the proper development of the new town, and some modifications include the exclusion of an area of some 275 acres of farmland west of the village of Worth and other land, totalling some 42 acres, in the north-western part of the area.

UNDERGROUND WORKINGS OF MODERN COLLIERIES

HOLMEWOOD No. 3 COLLIERY, MAIN ROADWAY

RAMCROFT COLLIERY, COAL FACE AT END OF COAL SHAFT



HOLMEWOOD No. 3 COLLIERY—UNDERGROUND SUB-STATION

HOLMEWOOD No. 2 COLLIERY, TRUNK BELT CONVEYOR

The Nationalised Mines and the Coal Supply Situation

By Sir RICHARD A. S. REDMAYNE, K.C.B.

No. II—(*Continued from page 36, January 10th*)

III. Nationalisation

THE Coal Industry Bill became an Act of Parliament on July 12, 1946, and although the vesting date, when the collieries pass from private to national ownership, was not until January 1, 1947, a good deal of work was accomplished towards meeting that end during 1946.

Compensation. — Statutory Rules and Orders have been made by the Minister of Fuel and Power towards furnishing information and particulars, exercise of options, valuation districts, of which there are to be 23, constitution of Compensation Units, together with certain necessary miscellaneous and general instructions. A tribunal, with Lord Greene as Chairman, Sir Lionel Cohen, another Judge, and Sir Harold Howitt, the well-known Chartered Accountant, was set up by the Minister of Fuel and Power to arbitrate as to the total amount of compensation to be paid to the colliery owners for their property, and by the beginning of August the global figure of £164,660,000 was arrived at after what was generally agreed to be a full and fair hearing of both sides of the case. We do not at the time of writing know, in arriving at this figure, what were the figures taken by the Board of net maintainable revenue and number of years' purchase. Probably the first was between £12,000,000 and £14,000,000 per annum, and the latter between 14 and 12 years' purchase. The compensation is to be in the form of stock, but we do not yet know whether it will be such as to return 2½ or 3 per cent. This has come to be known as Stage I in the Scheme of Valuation of colliery and trading assets. Under Stage II the global sum has to be apportioned among the various districts, and Stage III provides for the amount awarded to each district to be apportioned in turn among the various undertakings in each district.

In addition to the global sum, the amount to be paid for the ancillary assets, such as coke ovens, brickworks, railways, staithes, rolling stock, houses and farms will have to be assessed in respect of each unit. With the exception of stocks of coal and coke, and consumable stores, which will be paid for in cash, the compensation awarded will also be satisfied by the issue, at some future date, of scrip.

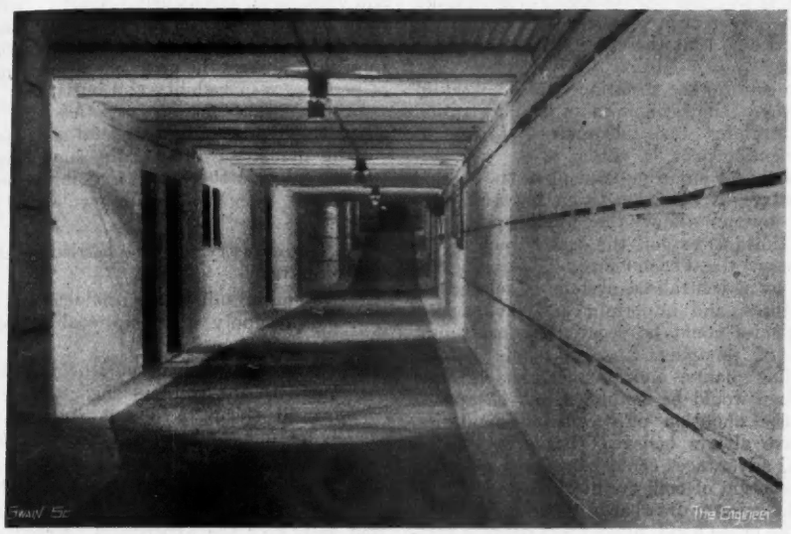
The next, or Stage II, was the setting up of the Central Valuation Board, which is at present engaged in the work of dividing the global sum between the 23 districts (which are to correspond in general with the areas for which district wage ascertainments were made in 1939). From the decision of this Board there is no right of arbitration. For the purpose of the setting up of District Valuation Boards, namely the Stage III, the Minister of Fuel and Power may group valuation districts together. In the case of non-acceptance by any colliery concern of a District Valuation Board's decision, there is right of submission to an Official Referee. A Panel of Referees is to be appointed for the purpose.

It is generally considered that the completion of Stages II and III and the transfer of the ancillary assets may occupy some two or three years.

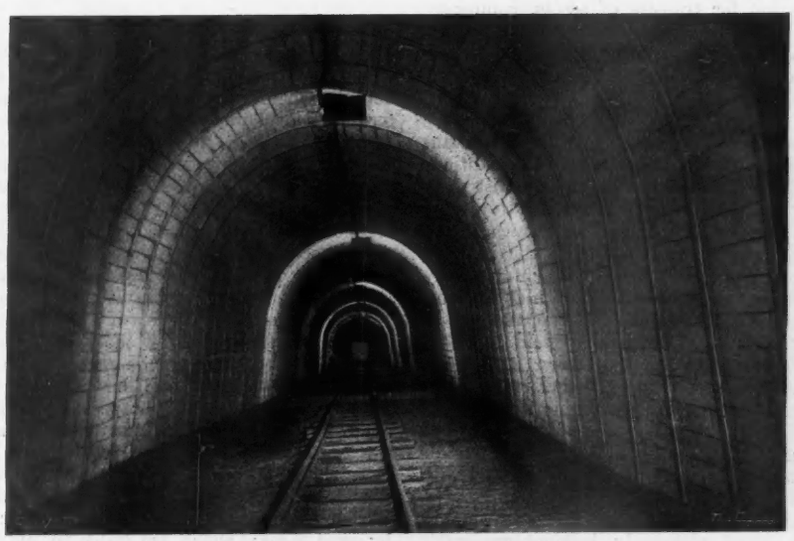
One would have thought, seeing that the fair figure to allot to a district is the sum of the true valuations within that district, that Stage II might have been dispensed with, instead of taking, as it were, two bites at the cherry, and Stage III alone adopted, dividing the global sum by the 800, or thereabouts, separate undertakings on the basis of their valuations scaling up or down as might be necessary.

Pending the determination of the amount of compensation payable, each concern will receive an "interim income" equal to half the profits for one of two specified periods computed on income tax principles, with certain adaptations to be prescribed. This "interim income" will be paid in cash for a period of two years from the vesting date (January 1, 1947). The alternative specified periods referred to above are the year ended June 30, 1946, or the average of two accounting periods last before July 1, 1944, and 1945, respectively.

Administration.—So much for the compensationary part of the Nationalisation Scheme. Turning to the Administrative side, this strikes one as being well conceived and well carried into effect. By reason of the qualifications and standing of the nine persons who constitute the Central Coal Board, there is a definite guarantee that the problems of the industry will be approached and dealt with, with knowledge, balanced judgment and integrity. The Chairman is paid a salary of £8500 per annum, and the other members £5000. The Board has already got to work and has established eight Divisional Coal Regional Boards, consisting of approximately six full-time members, with Chairman and Vice-Chairman. We have not so far been informed what salaries are paid to the members of these Boards, under whom there will be Area Boards. There will be a Production Division, with a Director and Deputy Production Director to each. Whereas the Central or National



UNDERGROUND ROADWAY WITH OFFICES AND WORKSHOP—HOLMEWOOD NO. 3 COLLIERY



MAIN RETURN AIRWAY—WILLIAMTHORPE COLLIERY

Coal Board is a statutory body, the Divisional Boards are not, being, as they are, appointed by the National Coal Board as part of its managerial staff. As from December 31st, the existing Boards of Directors of Colliery Companies, though continuing in being unless and until their Company is wound up, will cease to exercise any control whatever over the working of the collieries, each colliery concern passing, during the temporary period, into the hands of a Controller, that functionary, in many cases, being the present Chairman of the Company.

The interests of the general public are to be safeguarded by the creation of an Industrial Coal Consumers' Council and a Domestic Coal Consumers' Council, which are appointed by the Minister of Fuel and Power. These Councils will report to the Minister and not to the National Coal Boards, and if it appears to him, after consultation with the National Board, that a defect is disclosed in the Board's general arrangement for production, sale or supply of coal, coke or manufactured fuel, he may give directions to the Board for remedying the defect, which instructions they must carry out. The Annual Reports of these Councils will be laid before Parliament. The Minister, too, may appoint a Regional Industrial Coal Council, or a Regional Domestic Coal Council, for any prescribed locality. If such appointment appears to him to be expedient, such regional council would act under the Central Industrial or the Domestic Coal Council, as the case may be.

For the purpose of financing the National Coal Board, the Minister may make advances to the Board of sums not exceeding in the aggregate :—

(1) Within five years from the commencement of the Act, £150,000,000.
(2) During any subsequent period, such amount as Parliament may determine.

On the other hand, the National Board is to make to the Minister at such times and in such manner as he, with the approval of the Treasury, may direct—payments for recouping the expenses incurred by compensation for transfer of assets, compensation for severance, and refunds of capital outlay, payment of interim income and certain other financial commitments.

IV. What of the Future

The question which future historians will have to answer is—Were the conditions obtaining in the coal-mining industry at the close of the year 1945 such as to justify, from the point of view of economics, of the welfare of the miners, and of the national interest, such a great experimental change of ownership and administration as we have witnessed ? Time alone can give the correct reply. As Mr. Shinwell has said : "The implications of Nationalisation are clear ; unless we can provide a higher standard of service to the general community we shall fail."

Personally, I believe there was a middle course which might have been pursued with great advantage to all concerned, employers, workmen and the nation, and one which I think must ultimately become applicable to all branches of industry, namely, that of a real co-partnership between employers and workpeople.

The late Sir George Livesey, the Chairman of the South Metropolitan Gas Company, a man of broad outlook and of almost prophetic vision, who put that system into operation at his works, wrote to me early in the year 1906. "We have induced our people to invest in the Company's stock, and when they are shareholders, they take a much greater interest in the Company. They become, in fact, partners, which Mazzini prophesied would be the ultimate position of the workman," and, again, a little later, "Partnership in the business is the idea, and profit-sharing is the means whereby the men get the money for the investment . . . what the Labour Party want is a better and more even distribution of property, which is right enough, but there is a right and a wrong way, and I fear they are going the latter—the way of Socialism."

The system of co-partnership is rendered now much more practicable of application in the coal-mining industry in recent years than at the time Sir George Livesey wrote to me, by reason of the amalgamation of collieries so that there are fewer and larger units.

To sum up the situation. As I have said elsewhere the economies of administration and working attainable under a system of aggregation must be patent to every broad-minded and inquiring student of the mining industry. Keen competition between rival coal owners allows the foreigner in normal times to exploit the coal output of the country. Great economies could be achieved, too, by a centralised system of purchasing of stores, and important and far-reaching economies could be secured by centralisation of pumping, and, to some extent, winding plants, and, further, underground haulage would be simplified and cheapened by the abolition of eccentric boundaries. I have always believed that great economical advantages could be secured from the aggregation of colliery interests.

The gains or drawbacks of Nationalisation, on the other hand, hinge upon definite principles of human action and experience. Whatever results may accrue from such a policy, from the record of observation, I find great difficulty in believing that it will make for efficiency. During the period of control during the first World War, when I acted as production director and technical adviser to the Controller of the Coal-Mining Industry, the representatives of the State did their best. Control was at the time necessary, for it was imperative to impose unified action in important matters where there was no existing machinery within the industry capable of doing so. But the virtue was in the co-ordination and not in the hand directing it, and there can be no doubt that joint action from within, had it been available, would have produced a more effective and economical mechanism. Apart from the inherent difficulties of the case, Nationalisation has the disadvantage of removing from the industry the great energising forces of personal responsibility and initiative.

In conclusion, let me say this—and in this I think there will be general agreement —if the industry is to be of the same service to the nation in the future that it has been in the past, three basic requirements must be fulfilled :—

(*a*) The industry must be carried on at a profit.
(*b*) It must result in the production of an ample supply of cheap coal of good quality.
(*c*) It must be capable of providing such wages to the workers engaged therein as will ensure a decent standard of living and conduce to industrial peace.

Nationalisation is a great experiment. Let us hope it will be a successful one. But would not it have been advisable to have first seen how the experiment worked out in regard to the coal mines before embarking on further adventures ?

Civil Engineering in 1946

No. III—(*Continued from page 51, January 10th*)

Sea Defence and Coastal Works

In several parts of the country work has been progressing on reclamation and sea defence schemes. As part of an important foreshore development programme, the Alford Drainage Board is well ahead with a five-year scheme to protect and improve the length of coast between Mablethorpe and Huttoft, Lincolnshire. This exposed three-mile length of coast has been severely eroded and damaged in recent years. The scheme, which was prepared by Messrs. Lewis and Duvivier, the Board's consulting engineers, includes repairs to most of the existing stepped concrete walls ; the construction of new level toe walls to counteract the progressive lowering of the beach level by erosion, the raising of parapets which are overtopped under storm conditions ; and the replacement of timber breastworks by new walls in reinforced concrete. Over considerable distances the hinterland, which is rich agricultural land, is protected only by sand dunes, which are liable to sudden damage. These lengths are being protected now by reinforced concrete walls with aprons, stepwork and curved superstructure. About three-quarters of a mile of this type of wall has been completed in the Huttoft district, a typical length being illustrated in the accompanying engraving. There is also an extensive system of low groynes in course of construction. The preliminary estimate for the plan amounted to about £200,000, and total expenditure to date, including additional storm damage and emergency works, amounts to £135,000.

Many coastal towns have begun to place their piers and jetties in order, after the severe damage which generally resulted following requisitioning during the war. It is understood that with such structures practically 80 per cent of all timber decking and bearers have been found, on the average, to have "disappeared" or to be too rotten for use. In this connection, work done during the year on Eastbourne pier, under Mr. Ernest Latham as consulting engineer, is of interest. The pier was left with a large gap, a portion having been removed as a military measure. In repairing it, reinforced concrete "planks," to the design of Considere Constructions, Ltd., were laid over the gap section and elsewhere. Whereas concrete decking is commonly used for a concrete structure, such decking laid on a steel girder structure appears to be novel. This type of decking adds 10 cwt to 15 cwt per square foot deck load, which most original designs will easily accommodate, and is said to cost but little more than timber.

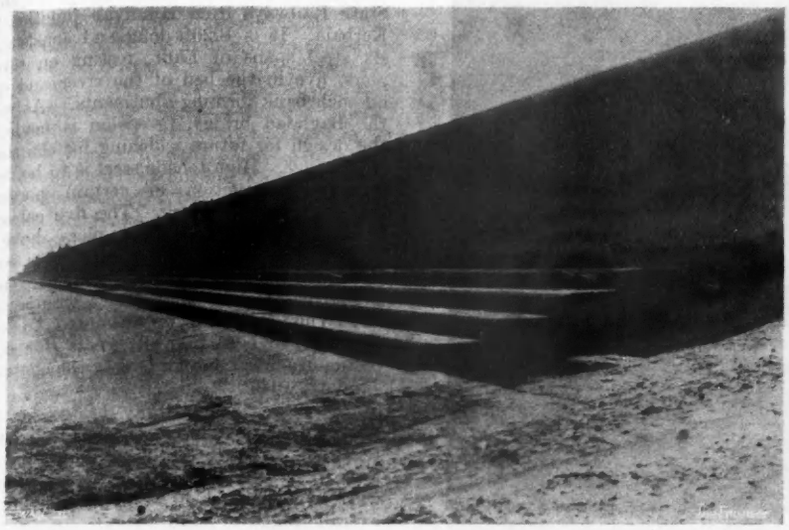
Hydro-Electric Development in Scotland

Amongst several schemes for Scottish power development announced by the North of Scotland Hydro-Electric Board were the Loch Sloy and Tummel-Garry projects.

Contracts valued at nearly £3,000,000 were placed in connection with the Loch Sloy scheme, and at about £1,750,000, out of a total estimated cost of £6,000,000, for the Tummel-Garry scheme.

Loch Sloy Scheme

The Loch Sloy scheme involves the construction of a dam at Loch Sloy, the driving of a tunnel through Ben Vorlich, and the erection of a power station of 130,000 kW on the shores of Loch Lomond. The contract for the dam has been let to Balfour Beatty and Co., Ltd. It will be a massive buttress concrete wall 1160ft long, with a maximum height of 165ft. The construction has been planned so that before it is finally completed water will be available to drive the turbines in the generating station. The contract for the main tunnel, the surge shaft and a subsidiary tunnel has been given to Edmund Nuttall, Sons and Co. (London), Ltd. It will have a horse-shoe shape section, with a finished width of 15ft 4in. It will take about two years to cut through 1¾ miles of the mica schist of Ben Vorlich. Sir William Arrol and Co., Ltd., will supply and erect steel pipelines to convey the waters under pressure from the tunnel to the water turbines at Inveruglas.



SEA DEFENCE WALL—MABLETHORPE, LINCOLNSHIRE

Tummel-Garry Scheme

One of the largest of the schemes at present under construction for the North of Scotland Hydro-Electric Board, the Tummel-Garry project, when published by the Board, aroused much controversy from amenity and fishery interests, and provoked considerable public discussion. It was finally approved by Parliament in November, 1945, and work was begun in the early months of 1946 in the Pitlochry area. Despite the difficult conditions prevailing with regard to labour and materials, it is understood that the constructional work is making headway. When completed, this scheme will provide an installed capacity of 148,000 kW in three stations.

Another scheme now in progress is the Fannich project, situated in Ross and Cromarty. This scheme is estimated to cost £1,000,000 and work on access roads has already started. It is planned to give an installed capacity of 24,000 kW in a power station near Grudie Bridge.

The engineers for the civil engineering works of the Tummel-Garry and Fannich schemes are Sir Alexander Gibb and Partners and for the electrical and mechanical plant, Messrs. Merz and McLellan.

Channel Islands

Work on St. Saviour's dam, Guernsey, which was abandoned in 1940, when the island was occupied by German troops, was resumed in 1946. Although the plant on the site had deteriorated, and timber and some of the exposed copper sealing strips had been removed, it was found that no serious damage had occurred to the work completed before the occupation. A full description of the scheme, designed to augment the island's domestic and industrial water supply, was given in our issue of March 29, 1940. The dam is a mass concrete gravity structure of overall length of about 880ft, and with a height from lowest foundation level to pathway level of 125ft. The water held up will have an estimated volume of 250 million gallons and a maximum depth of 70ft. When abandoned, the work was well advanced and the contractors, Pauling and Co., Ltd., in resuming construction last year, simply carried on from the stage reached in 1940, after a brief period for rehabilitating the plant. French labour was recruited from Normandy, and it is understood that very satisfactory progress is being made, about 1000 cubic yards of concrete being placed per week. A photograph taken in October, 1946, and reproduced herewith, shows the downstream face of the dam, near the east corner of the overflow pool. The joint engineers for the work are Sir William Halcrow and Partners and Messrs. T. and C. Hawksley.

The construction of a breakwater in Maseline Bay, Sark, was also resumed during the year. The contract for this work was two-thirds completed by Sir Lindsay Parkinson and Co., Ltd, when it had to be abandoned in January, 1941. The breakwater when completed will provide a berth for boats at all states of the tide, whereas the present Creux harbour to the south dries out at certain low tides. At Sark the range of tide is 31½ft, and the new breakwater is to provide 15ft of water alongside at low water exceptional spring tides. It is to be 175ft long, 28ft wide at the top, and of an average height of 52ft above the sea bed. It is founded on rock and is constructed of precast concrete blocks of 10 tons and 5 tons weight, laid in sloping bond. Access to the breakwater has been provided from the Chansee St. Chenais by excavating the cliff to form a roadway 20ft wide. This road is carried through the Cagnon by a tunnel 75ft long and 12ft wide. The engineers for the scheme are Messrs. Coode, Vaughan-Lee, Frank and Gwyther.

Crown Agents for the Colonies

As the result of concentrating for six years upon military requirements and because of the great difficulties experienced in the supply of materials the work of the Crown Agents for the Colonies in the civil engineering field has necessarily been confined during the past year mainly to rehabilitating and developing existing roads, railways and harbours. In Nigeria, for example, the current shortage of fats has led to an increased demand for ground nuts, and to cope with the new traffic 160 miles of railway track between Minna and Jebba was relaid.

For the Nigerian Government, the Crown Agents ordered two large suction dredgers

ST. SAVIOUR'S DAM, GUERNSEY—1946

during the year, from William Simons and Co., Ltd., of Renfrew, for which Messrs. Coode, Vaughan-Lee, Frank and Gwyther are consulting engineers. Both vessels are stern well, hopper suction, dredgers for drag dredging in open water and for harbour dredging in stiffer materials by means of rotary cutting gear. The larger vessel will be 340ft long and will have a hopper capacity of 4000 tons. She will have a 33in dredging pump and pipe system, and will be capable of dredging from depths up to 42ft. The hopper is to be fitted with Lyster valves for discharging the spoil, but the hopper load can also be discharged overboard by pipeline or to barges. The smaller vessel will be similarly equipped, but will have a length of 305ft, with 2500-ton hopper capacity and a 27in dredging pipe system.

HAWKESBURY RIVER BRIDGE—AUSTRALIA

Schemes are in hand by the Crown Agents for improving harbour, water supply and drainage works in many of the colonies, but the work done during the year, as already mentioned, has been mainly on heavy replacement programmes. The Colonial Development Fund, recently instituted, was increasingly used to investigate rural and urban water supply and road requirements. As an example of the working of this fund, parties of engineers made up of Crown Agents and various consulting engineers' representatives have been enabled to tour Nigeria to conduct engineering investigations.

IRAQ

The Crown Agents for the Colonies also act as agents for the Government of Iraq, and have in hand several important railway and road bridging and improvement schemes, for which Messrs. Coode, Vaughan-Lee, Frank and Gwyther are consulting engineers, and Holloway Brothers (London), Ltd., contractors.

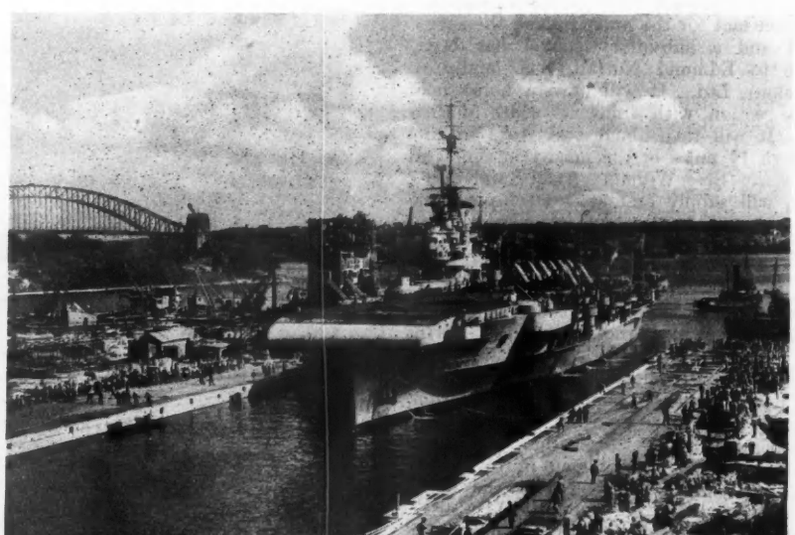
Of three bridges to be built, the most important is the Baghdad railway and road bridge across the River Tigris, about 1½ miles north of the North Bridge in Baghdad. This combined bridge will cost about £965,000. The contract was let late in 1945, and it is estimated to take three years to complete the work. It will replace the existing road bridge of boats and will carry the metre-gauge railway across the river, connecting two parts of the Iraq railway system. At the same time a reconstruction will take place of the railway station and marshalling yards. The bridge will have an overall length of about 1500ft, with three main steel spans 340ft 8in long, alternating with four shorter spans, 121ft 8in long, resting upon six piers and two abutments. Approach viaducts will carry the railway and two shorter viaducts will be built to carry the roadway and footway up to the abutments. The roadway will be 18ft wide and provision has been made in the design for future widening of the railway track to standard 4ft 8½in gauge. Three of the piers of the main spans are to accommodate pumping plant to supply water to the railway yards on the West bank at Shalchiyah and to the new Baghdad West Railway Development scheme. The six piers are founded on caissons sunk in the bed of the river under compressed air, and the two abutments are founded on piles. The new layout of roads and railway tracks will necessitate five overbridges on the railway viaduct, and two overbridges over branch roads at the foot of the roadway viaduct.

The second bridge of the three is the Euphrates railway bridge, about a mile downstream of the Hindiyah barrage, on the diversion of the branch line of the Iraq State Railways from Hindiyah junction to Kerbala. It is 1020ft long and consists of six steel spans of 170ft, resting on seven piers, five in the bed of the river and one on each bank forming abutments. As with the Baghdad bridge, provision is made in the design for future widening for the standard gauge. High tensile steel is to be used in the construction of certain portions of the permanent work. The five caissons or lower portions of the piers have a working chamber for sinking under compressed air, and the abutments are also similarly to be sunk under compressed air. This structure is estimated to cost £180,000, and to take 2¼ years for completion from the date of letting the contract, January, 1946.

The Lesser Zab railway bridge, on the Kirkuk-Erbil extension of the Iraq State Railways is the third of these developments. It is to be similar to the Euphrates bridge, with five spans, instead of six, giving an overall length of 850ft.

AUSTRALIA

Amongst the principal civil engineering achievements in Australia during 1946 were the completion of the Hawkesbury river railway bridge, replanning for Sydney Circular Quay railway, and progress with hydro-electric plant construction at Wyangala dam, New South Wales. In all six states of the Commonwealth large post-war public works, involving housing, water conservation, rail extension and sewerage expansion were put under way. Amongst the projects for which approval was granted was the Clapp rail standardisation and



H.M.S. "ILLUSTRIOUS" ENTERING CAPTAIN COOK GRAVING DOCK—SYDNEY HARBOUR

modernisation scheme at a total ultimate estimated cost of £223,000,000.

Hawkesbury River Bridge

Construction of the new railway bridge over the Hawkesbury River, forty miles north of Sydney, has been completed. The bridge, illustrated in an accompanying engraving, has created great interest in engineering circles because of its unusual design and the great difficulty experienced in founding the piers on solid rock. The total length from one abutment to the other is 2005ft. There are two truss spans each 440ft long, eight plate girder spans 90ft long, and eight rolled steel joist spans, aggregating 320ft. Seven of the piers of the bridge are supported on caissons which are founded at various depths, according to the formation of the river bed. These caissons are rectangular and at the cutting edge measure 51ft by 29ft, reduced to 49ft 6in by 26ft at a point 12ft above the cutting edge. The river bed was excavated by grabs through dredging tubes. The caissons are made of reinforced concrete, and there are eight dredging tubes arranged in pairs throughout. These dredging tubes begin 7ft above the cutting edge and extend the full height of the caissons, terminating at a point approximately 12ft below high water level. The whole of the work, including fabrication of the steelwork, was carried out by the staff of the New South Wales State Government Railways.

Sydney Circular Quay

Replanning of the Sydney Circular Quay is at last in hand, after many delays and postponements. Work is now under way on 8ft 6in diameter reinforced concrete cylinders, 141 of which will provide the foundations for the station building. So far more than 3500 lineal feet of cylinders have been completed, and 18 hours' work per day under compressed air is being carried out. The deepest cylinder sunk is 74ft below sea level, but it will be necessary to go down to 85ft for certain of the cylinders.

Hydro-Electric Plant

Considerable progress has been made with the construction of a hydro-electric plant at the base of the Wyangala dam, near Cowra, New South Wales. The dam, which has a maximum height of 190ft, with a length of 1000ft, gives a storage capacity of 304,000 acre feet. The plant to be installed will comprise one English Electric vertical shaft reaction turbine, generating 10,000 horsepower, under a head of 154ft. Transmission will be by 19 miles of line at 66,000 volts.

Captain Cook Graving Dock

The Captain Cook graving dock in Sydney Harbour came into full use during the year. This dock, built at a cost of almost £10,000,000, to accommodate the largest capital ships as well as liners of the "Queen Mary" class, proved its value in the closing stages of the Japanese war. During the progress of the war in the Pacific, the battleships "Duke of York," "Howe" and "Anson," as well as the aircraft carriers "Indomitable," "Illustrious," "Implacable," "Indefatigable" and "Formidable," were all dry-docked for overhaul.

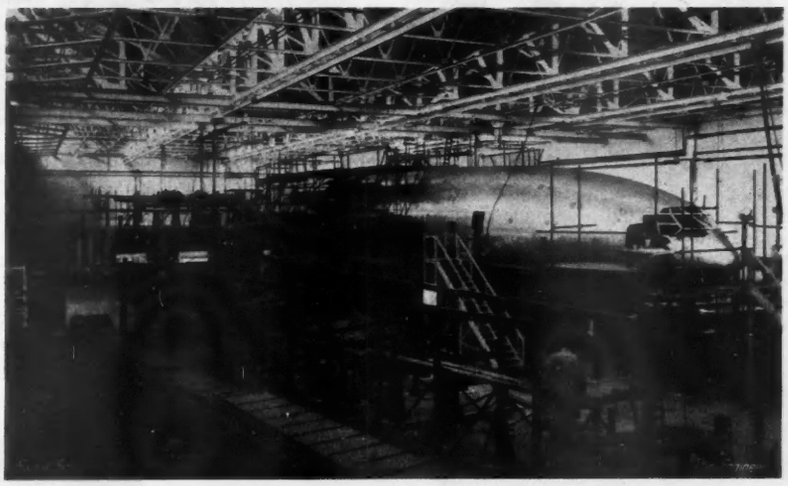
An accompanying illustration shows H.M.S. "Illustrious" entering the Captain Cook dock, with Sydney bridge in the background. The consulting engineers for the dock were Sir Alexander Gibb and Partners.

Aeronautics in 1946

No. III—(*Continued from page 44, January 10th*)

Projected and Experimental Aircraft

WE have already briefly referred to the Bristol "Brabazon I" or type 167 air-liner. This giant of the air, weighing about 125 tons, is shown during construction in a photograph reproduced herewith. It will, in the first prototype, be powered by eight Bristol "Centaurus" engines, coupled in pairs, with a total of nearly 25,000 b.h.p.; each pair of engines will drive a six-bladed contra-rotating Rotol airscrew. The second of the four aircraft of this type ordered by the Government to be powered by eight "Proteus" gas-turbine propeller units will follow about a year after the first, which is expected to be flying in the early summer of 1947. This great machine has a span of 230ft, a length of 177ft, and a height of 50ft, and is the largest British air-liner under construction. It is, of course, to be pressurised, and it will have a maximum speed exceeding 300 m.p.h. at 25,000ft, with cruising speed of about 250 m.p.h. at the same altitude. There will be accommodation for 72 passengers and a crew of thirteen.



Bristol "Brabazon I" Air Liner Under Construction

Of similar proportions, but not yet so advanced in construction, is a projected Saunders-Roe flying-boat, the "Saro SR/45," with span of 220ft and accommodation for up to 100 passengers. The gross weight of this machine is planned to be about 290,000 lb, and it will be propelled by six gas-turbine propeller units of, at present, unspecified type. Accommodation will be on two decks, fully pressurised, and its range is to be about 5000 miles in still air.

An aeroplane which is now in an advanced stage of construction is the Airspeed "Ambassador," a twin-engined civil transport with planned accommodation for 28 to 50 passengers. This machine will be suitable for the short and medium services of air transport, ranging from 200 to 1500 miles, and is designed to Government orders. It is a high-wing monoplane, with tricycle undercarriage, and with moderate wing loading of about 37·5 lb per square foot, to permit it to be operated from secondary aerodromes. The "Ambassador" has twin Bristol "Centaurus" engines, giving 2610 b.h.p. each for take-off, but, alternatively, gas turbines can be fitted when available.

One of the most interesting developments of the year has been the experimental fitting of two Rolls-Royce "Nene" jet units in place of the outboard "Merlin" engines on an Avro "Lancastrian" air-liner. This machine has flown on many occasions, notably at the S.B.A.C. display last September, and more recently in connection with the Paris Aviation Show. Although it is described as purely an experimental flying test bed, all who have flown in it are enthusiastic as to its qualities of smooth, quiet and vibrationless flight when using the jet engines, the propellers of the reciprocating engines being feathered and motionless. The experiment is part of the Rolls-Royce Hucknall development division's programme, under a Ministry contract, and its objects are stated to be to assess the efficiency of such jet engines in flight and investigate their performance in heavy aircraft. An accompanying engraving illustrates the appearance of this hybrid machine.

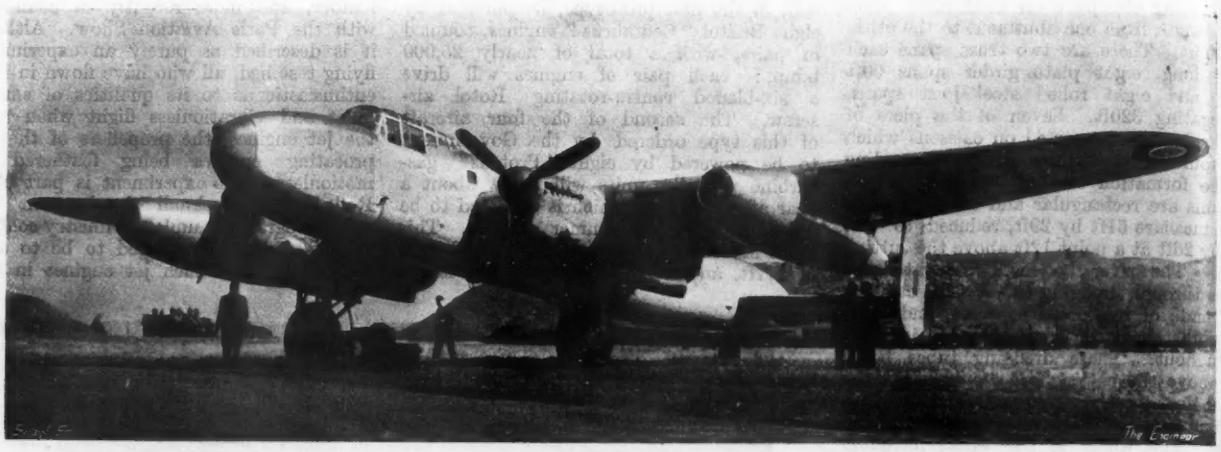
Another notable machine of the year is the de Havilland "D.H. 108" experimental aircraft, with swept-back wings, which has produced much valuable information with regard to high-speed flight in the "sub-sonic" speed range. Many of our readers will recall with regret that Mr. Geoffrey de Havilland lost his life when flying one of these aircraft during the year, probably when travelling at extremely high speed. This single-seat research aeroplane illustrated in one of of our engravings, is propelled by a de Havilland "Goblin II" jet unit, with a standard static thrust of 3000 lb but modified in this case to give increased output. Performance figures are not available, but it is claimed that the present world speed record figure of 616 m.p.h. in level flight has been exceeded. The aircraft has a span of 39ft and is of wood and metal construction. In spite of the regrettable accident to the early "D.H. 108," research with this type of aircraft is going forward at the de Havilland works.

On December 16th of last year, the Armstrong-Whitworth "A.W. 52" jet tailless experimental aircraft was shown for the first time. This machine, it is hoped, will be flying this month for the first time and will be used as a flying laboratory for research into the behaviour of all-wing,

tailless types of aircraft. It will be recalled that during the past year the "A.W. 52G" towed glider, of all-up weight of 6000 lb, and 53ft span, was built and flown for some 200 hours of testing. The "A.W. 52" is a scaled-up version of this glider and is propelled by twin Rolls-Royce "Nene" jet engines buried within the wings as indicated in the photograph we reproduce. Although much larger than the glider—the "A.W.52" has a weight of about 30,000 lb and a span of 90ft—accommodation is provided only for a pilot and observer and extensive research instrumentation. Nevertheless, it is hoped that further development and enlargement of this type, perhaps to a minimum weight of 180,000 lb and span of 160–180ft, would result in an aircraft of the true flying-wing pattern, in which everything would be stowed within the wing which would be thick enough to give headroom for passengers. No performance figures are available for the "A.W. 52," but it is interesting to note that the machine has laminar flow wings which maintain laminar flow up to 60 per cent of the chord, the profile drag is approximately halved. For such wings the surfaces must be smooth and accurate to a high degree. A jigging method of construction which has been adopted by the firm, is claimed to give variations from the ideal skin profile of no more than one or two thousandths of an inch in any 2in length. A further point of much interest is that there is an arrangement for boundary layer suction to overcome tip stalling at slow speed. Suction is provided by a venturi action produced by flaps within the jet engine air intakes. This suction comes into operation automatically if the engines are throttled or if the control column is pulled right back. Tricycle landing gear, having a long vertical travel, permits the aircraft in an emergency to be flown straight on to the ground without flattening out.

Preliminary details were released during the year of a high-speed single-seat jet flying-boat, under construction by Saunders-Roe, Ltd. This machine, known as the "Saro SR/A1," will probably be the first jet flying-boat ever to be built. It is the advent of the jet engine that has made possible such a venture, for with a normal flying-boat the propellers must be mounted high to give water clearance. In the new design, two jet engines, Metrovick "F2/4" units, which are of relatively small diameter, are placed side by side within the hull, permitting the wings to have a high-speed characteristic. This arrangement is claimed to give approximately the same width of hull as that demanded by hydrodynamic considerations, and, in addition, to give good single-engine flight characteristics and economy when cruising on one engine. Air intakes are at the bow and the jet outlets aft of the wing trailing edge on each side. The wing arrangement is high, with a single fin and rudder, and the pilot is accommodated in a pressurised cabin forward of the wing with emergency ejection device.

Another novel project, of which full details are not yet available, is a Vickers-Armstrongs monoplane amphibian, designed to replace the "Sea Otter." Interesting features of this machine, known as the "S. 14/44" amphibian, are high-lift wings with full-span leading edge slats, together with slotted flaps and variable incidence gear. This equipment permits the wing to be set at the best angle for take-off, whilst in level flight the incidence can be adjusted so that the drag of the hull is a minimum. Similarly, when landing, it is possible to achieve the high angle of incidence necessary to develop the high-lift coefficient for which the wing is designed without the expense of drag under level flight conditions.



AVRO "LANCASTRIAN" AIR LINER WITH TWO ROLLS-ROYCE "NENE" JET ENGINES

DE HAVILLAND "D.H. 108" RESEARCH JET AIRCRAFT

ARMSTRONG WHITWORTH "A.W. 52" TAILLESS JET AIRCRAFT

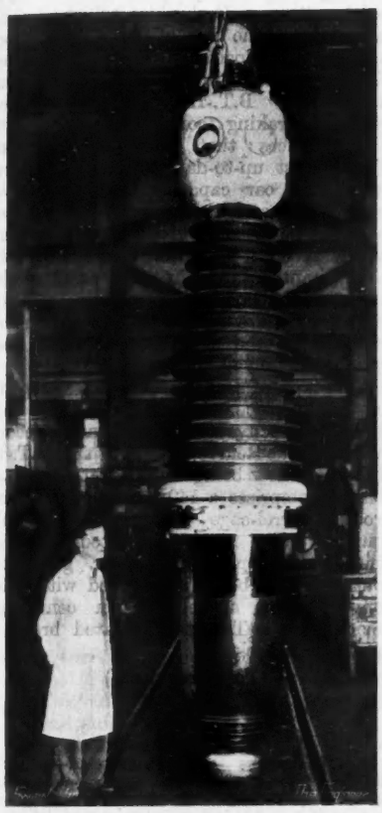
Electrical Engineering in 1946

No. II—(*Continued from page 57, January 10th*)

High-Voltage Transmission and Cables

ALTHOUGH the voltage of primary transmission lines in this country at present remains stabilised at 132 kV, much experimental work is being done at 264 kV, in anticipation of the time when it will be economic to adopt the higher transmission voltage. In America and on the Continent where much longer transmission distances are generally encountered, the trend towards higher voltages is more marked and even before the war power was being transmitted at 220 kV. At voltages of this order, the possibilities of d.c. transmission begin to claim attention.

Special significance, therefore, attaches to experimental work such as that carried



Bushing for H.V. Testing Transformer

out by Brown Boveri, Ltd., of Baden, indicating that many of the technical problems associated with high-voltage d.c. transmission have been solved. This firm, in particular, claims that modern mutators, suitably connected in banks, can be used for transmitting power in bulk by direct current over long lines with the necessary degree of reliability.

An equally valuable contribution to high-voltage transmission technique has been made by a number of British cable manufacturers who have intensified development on gas-filled and other forms of super-tension cable. Progress in this field was admirably summarised in a C.I.G.R.E. paper, "Super-Tension Cables," presented in Paris last summer by Dr. P. Dunsheath and C. H. Jolin. A particular design of gas cable, known as the impregnated pressure type, formed the subject matter of another paper read at the same conference by Dr. L. G. Brazier.

Continued progress has been made in designing gas cables for the higher voltages. As long ago as 1936 for example, a short length of single-core 264 kV-impregnated pressure cable (BI-Callenders, Ltd.) was laid for extended stability test at the K.E.M.A. laboratories in Holland. More recently, Enfield Cables, Ltd.—pioneers in the development of another design known as the compression cable—has installed an experimental length of single-core 264-kV cable with joints and sealing ends for test at its Brimsdown works.

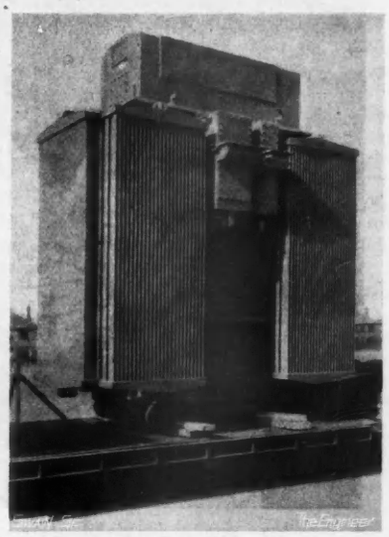
Transformers

Transformer manufacturers were fully engaged during the past year in meeting the very heavy demand for transformers for a wide variety of applications. Much of this work was concerned with extensions to power stations and to transmission and distribution systems at home and overseas —work that had been held up during the war. Although repeat orders for "standard" transformers form the bulk of this work development of new designs has in no way been neglected.

For example, further progress has been made with the "stress control" method of design developed by Ferranti, Ltd., to give increased protection against lightning surges. The range of voltage and kVA rating to which stress control can be applied has been extended; in particular, this design is now being used for small distribution transformers having cross-over windings, and at the other end of the scale for high-voltage, fully-insulated windings to operate with Petersen coils. Another recent development by the same manufacturer is the substitution of a moving-coil regulator for on-load tap change gear in power transformers, providing smooth voltage control and eliminating all switches, contactors and choke coils. At the same time, improvements have been made by Ferranti, Ltd., in their contactor type of on-load tap change gear for the medium range of power transformers.

During the year, the first of three high-voltage testing transformers was completed by the British Thomson-Houston Company, Ltd., for use in its Rugby works. The second equipment is now in hand. These transformers are designed to give a maximum test voltage of 364 kV when supplied at 12 kV. The unusually high rating of these transformers (1650 kVA) is necessary to anticipate the heavy charging-current requirements of the very large high-voltage transformers of the future. A point of interest about the design is the provision of a high-voltage tapping at 350 kV, whereby, if the three units are connected in cascade, each can be supplied at 12 kV from the previous unit. The 350-kV and 362-kV connections are brought out through the same double conductor condenser bushing which is illustrated in the accompanying engraving. These bushings, designed for normal operation at 284 kV, with a flashover value of 900 kV, are 21ft long overall. An ammeter is mounted in the head of the bushing as shown in our illustration.

Orders completed or in hand for the C.E.B. are representative of the transformer industry's intensive activity during the year. For example, the Metropolitan-Vickers Electrical Company, Ltd., has completed a 66·7-MVA, 11/66-kV three-phase indoor unit for Fulham, two 60-MVA, 33/132-kV duplicate outdoor units for Aldershot and a 37·5-MVA, 11/33-kV natural-cooled outdoor unit for Stalybridge. Transformers of 60 MVA and 45 MVA at 132 kV are among the large units delivered during the year by Ferranti, Ltd. Two other manufacturers, C. A. Parsons, Ltd., and Bruce Peebles also have more work in hand or on order than ever before, both for the home and export markets. A typical Bruce Peebles product is the 5000-kVA transformer illustrated herewith. This unit, one of a number supplied to Edinburgh Corporation for outdoor installation in residential districts, has its oil conservator and radiators symmetrically arranged to give a pleasing external appearance. Typical of the large number of transformers built for export by British manufacturers is the 50-MVA, 150/15·6-kV three-phase out-



5000 kVA Outdoor Transformer

door unit made by the British Electric Transformer Company, Ltd., for the French Republic.

Industrial Electrification

At a time when this country's labour force is limited, the need for greater output requires increased productivity and the extended use of electrical drives. As a result, the present demand for electric motors so far exceeds the available supply that long delivery times may be expected to persist for some time to come before most manufacturers can return to the normal state of being able to supply motors from stock. In an effort to reach this goal some firms have concentrated almost the whole of their production resources on the manufacture of their standard lines of machines.

Nevertheless, some interesting technical advances have been recorded during the past year. For example, Laurence, Scott and Electromotors, Ltd., of Norwich, have developed a machine known as the "Speedmaster" for supplying and controlling variable speed squirrel cage motors. The "Speedmaster," which is a development of the well-known "N.S." variable speed a.c. motor, is essentially a frequency-changer in the form of a single machine. Its rotor has a commutator at one end and three or six

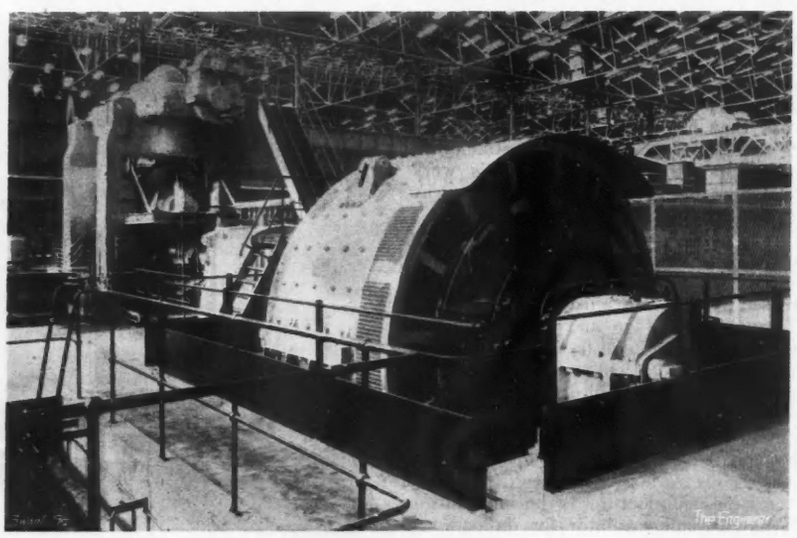
sliprings connected to the same rotor winding at the other end. Supply from the a.c. mains is fed directly to the stator and through an induction regulator to the commutator. The "Speedmaster," therefore, runs as a variable speed motor under the control of the induction regulator. Current from the sliprings of the "Speedmaster" is collected and fed to one or more variable speed three-phase squirrel cage motors. At standstill the frequency and voltage at the sliprings are a maximum, but as the machine gathers speed the frequency and voltage are reduced until at synchronous speed they become zero. Any change in the angular disposition of the induction regulator alters the speed and therefore the slipring voltage and frequency of the "Speedmaster." The resulting change in the supply to the variable speed motor or motors causes a corresponding change in their speed. These driven machines, therefore, come under the complete control of the induction regulator over a wide speed range. This system of control has evident advantages when applied to the individual drive of rollers in mills and generally in situations where the low inertia and inherent robustness of the squirrel cage motor are factors of importance. In rolling mills, alone, L.S.E., Ltd., has supplied three "Speedmaster" units driving and controlling twenty-nine motors.

The same company records important improvements in several recent Ward-Leonard installations. The first improvement is obtained by providing the generator of the Ward-Leonard set with self and separately excited shunt field windings. This change substantially reduces the time required for reversal of the d.c. motor and therefore diminishes the mechanical stresses. The second modification consists in the introduction of self and separately excited shunts in the low-speed steps and is used, for example, in crane drives which require very low speeds, combined with precision and consistency. With the ordinary Ward-Leonard system, the indeterminate effect of residual magnetism at very weak values of excitation makes consistent slow running impossible, but with the modified system it is claimed that speeds down to one-hundredth of full speed can be achieved in perfect safety.

Without embarking upon a lengthy catalogue it is impossible to indicate the scope and extent of current work in industrial electrification, embracing scores of manufacturing industries, both at home and overseas. The few examples that follow are, however, typical of a limited field of engineering applications.

An interesting mill installation is shown in the accompanying engraving, which illustrates a 3000 h.p. motor driving a light alloy reversing mill in the Falkirk works of the British Aluminium Company, Ltd. This reversing motor derives its supply from a motor-generator set driven by a 2870-kVA amplidyne-controlled synchronous motor which can be arranged for operation either at constant power factor or constant reactive kVA. The mill duty involves rapid and frequent fluctuations between no load and full load. Under such conditions the use of automatic power factor control ameliorates the severity of the demand on the supply system and permits the use of a smaller synchronous motor.

More recently a new 80in cold reduction reversing strip mill (described in THE ENGINEER November 29, 1946) was put into operation by John Summers, Ltd., at its Shotton works. The work rolls are driven by a 2500 h.p. 93–186 r.p.m. d.c. motor, while each of the two collapsing reels is driven by two 500 h.p. 200–675 r.p.m. d.c. motors in tandem, through a 3·86 to 1 reduction gear. Power for the mill motors comes from a motor generator set comprising a 3900 h.p., 500 r.p.m., 6·6 kV synchronous motor, driving a 2200 kW, 600 V main generator and two reel booster generators of 456 kW ± 338 V. The Ward-Leonard system provides the main mill control. Accurate control of the preset strip tension is achieved by "Metadyne" control. The main electrical plant was manufactured by Metropolitan-Vickers Electrical Company, Ltd.



3000 H.P. MOTOR DRIVING A LIGHT ALLOY SHEET MILL

A novel application of electronic speed control is used in the drive of a veneer-peeling lathe, built for the Forest Products Research Association, Ministry of Works. This lathe strips a continuous sheet of veneer from logs 4ft or 5ft long. For satisfactory operation, the rotational speed must increase as the diameter is reduced by peeling, so that the peripheral speed of the log may remain constant. The electrical equipment, designed and built by the G.E.C., Ltd., comprises a 60 h.p. variable speed d.c. motor, with Ward-Leonard control. Speeds up to 900 r.p.m. are attained by voltage variation and from 900 r.p.m. to 2700 r.p.m. by shunt regulation. The motor generator set consists of a 100 h.p. slipring motor driving a 65-kW, 230-V generator at 1450 r.p.m. The electronic voltage-balance control equipment has two separate functions: first, to keep a constant spindle speed while the job is being set up, and, secondly, to keep a constant cutting speed during actual working. Both of these conditions are fulfilled to an accuracy of 2 per cent. A conveniently situated control desk carries start and stop push buttons, instruments and indicating lamps, together with two speed indicators, one showing the rotational speed and the other the peripheral or cutting speed of the log.

MINING

To deal adequately with mining electrification would require a separate article. For our present purpose, a brief reference to the activities of a single firm will suffice to indicate the lines upon which a number of manufacturers are working to assist in improving mining efficiency.

Recognising the importance of rapid coal handling, a Derbyshire colliery (which has adopted the use of large mine cars for increased loading) is being supplied with a medium horsepower a.c. winder, fitted with B.T.-H. speed-compensated dynamic braking control, together with other devices that will make it one of the most up-to-date winders in operation. The car capacity has been raised to 4½ tons and the rope speed reduced to 14·4ft per second, giving a very efficient cycle. A 30 h.p. motor installed by the same manufacturer in the Summersales winder of the Pemberton Colliery Company, Ltd., provides evidence that the economic problems of the small winder have been successfully solved.

A number of schemes have been prepared for the replacement of subsidiary rope haulages by conveyor installations, as recommended in the Reid report. A typical B.T.-H. equipment now being installed at a Midland colliery comprises a 140 h.p., 3·3-kV flameproof squirrel-cage motor with hydraulic coupling. The motor is started direct on line by flameproof contactor gear, the control circuit being interlocked with other conveyors by a belt driven centrifugal device with a Thrustor operated brake to prevent run back.

(To be continued)

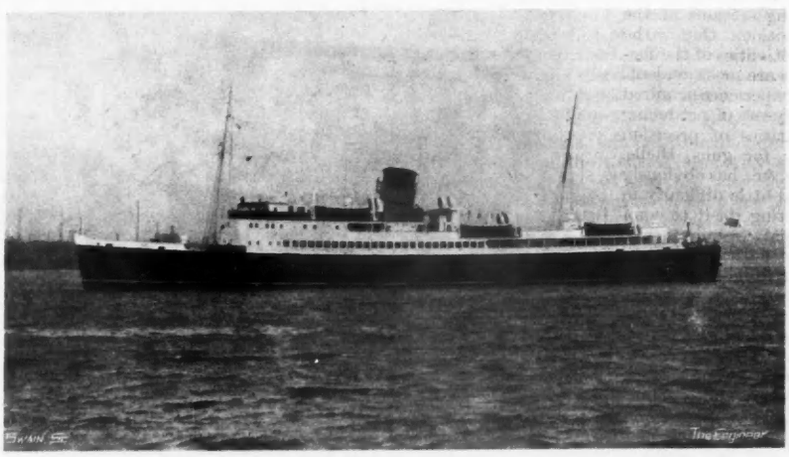
MINING STORES AND EQUIPMENT.—All raw materials, stores, plant and equipment supplied against any colliery undertaking's order for the purpose of "coal industry activities," as defined in Section 62 (1) of the Coal Industry Nationalisation Act, 1946, and delivered to the National Coal Board after January 1st will be accepted and paid for by the National Coal Board at the end of the month following delivery or otherwise, as may be agreed. This is subject to the right of repudiation in Section 7 (2) of the Act in the case of contracts entered into after August 1, 1945, where the Board considers that the terms and conditions of purchase were unreasonably imprudent or that the purchase was unnecessary. The Board states that it has no intention of repudiating any reasonable order or agreement made in good faith and in accordance with the usual practice of the trade. Similar remarks apply to orders placed in respect of goods required for the purpose of "transferred allied activities," as defined in Section 63 (1), where the goods are delivered after the relevant vesting date, which may be January 1, 1947, but in many cases will be considerably later. Such direct contracts as may exist between suppliers and the Ministry of Fuel and Power will continue until expiry. Where new central contracts may be necessary, they will be negotiated by the Supplies Branch of the National Coal Board, the temporary address of which is Supplies Branch (S.S.2), National Coal Board, c/o Ministry of Fuel and Power, 7, Millbank, London, S.W.1.

Shipbuilding and Marine Engineering in 1946

No. III—(*Continued from page 53, January 10th*)

CROSS-CHANNEL SHIPS (*continued*)

ANOTHER cross-Channel steamer of 1946 was the "King Orry," designed and built by Cammell Laird and Co., Ltd., of Birkenhead, for the Isle of Man Steam Packet Company, Ltd. As will be seen from the accompanying illustration, the ship has a single funnel with two pole masts and a raked stem and cruiser stern. In addition to the ordinary rudder an auxiliary bow rudder is provided. The "King Orry" has a length of 344ft 3in, a breadth moulded of 47ft, a depth moulded to shelter deck of 26ft, and a designed speed of 21 knots. Her gross tonnage is 2500. She is designed to carry 2300 passengers in the first and third-class accommodation and provision is also made on the shelter deck for carrying motor buses. The propelling machinery is of the Parsons geared turbine type with single reduction gearing and a propeller speed of 275 r.p.m. Astern power is 70 per cent of the ahead power.



ISLE OF MAN STEAMER "KING ORRY"

Steam is raised in three Babcock and Wilcox oil-fired boilers, constructed for a working pressure of 250 lb per square inch. The auxiliary generating plant consists of two 150-kW turbo-generators and an emergency generator.

During the year Cammell Laird also completed two 360ft, 3818 gross ton ships of 5396 tons deadweight carrying capacity for the West African service of John Holt and Co. (Liverpool), Ltd. They are cargo carriers, but have accommodation for twelve passengers. The propelling machinery consists of a set of 2500 s.h.p. triple-expansion engines working in conjunction with a Bauer-Wach exhaust turbine; steam at 220-lb per square inch is generated in two single-ended oil-fired boilers.

SOME MACHINERY OUTPUTS

The year 1946 saw no diminution in the manufacture of standard reciprocating steam units, embodying the lessons learned during the war in the design and operation of such engines. At David Rowan's works in Glasgow, several sets of triple-expansion engines were completed, and both turbine and Rowan-Doxford engines were constructed. Eleven vessels aggregating 50,500 i.h.p. were completed along with nine additional boilers of 5634 i.h.p. On the North-East Coast, the North Eastern Marine Engineering Company, Ltd., at Wallsend-on-Tyne and Sunderland, completed geared turbines, water-tube and Scotch boilers, and triple-saturated triple-reheated, triple-superheated and twin-triple superheated engines, totalling with three N.E.M.-Doxford oil engines of 13,970 i.h.p., a total of 58,135 i.h.p. of steam machinery and twenty-five boilers of 25,785 i.h.p. total output. During the year the company manufactured no less than 154,000 i.h.p. of marine superheaters for 170 boilers, which included not only superheaters installed in new ships, but those for a number of merchant vessels which were converted by the firm to the use of highly superheated steam.

At the associated company of George Clark (1938), Ltd., Sunderland, eight sets of triple-saturated and triple-superheated engines were built, aggregating 29,604 i.h.p., and twelve boilers of 5382 i.h.p. capacity, totalling 34,986 i.h.p. At John Dickenson and Sons, Ltd., of Sunderland, fifteen sets of 220 i.h.p. compound steam engines were constructed for T.I.D. tugs.

At West Hartlepool, Richardsons Westgarth and Co., Ltd., work was continued on the design and production of geared turbines and water-tube boilers of the Foster-Wheeler machinery for seven ships, aggregating with one R.W.-Doxford oil engine of 4122 i.h.p., a total of 57,366 i.h.p. In addition two sets of 8820 i.h.p. geared turbines and boilers were completed for export, giving a total of 75,006 i.h.p. Work was also done in installing three Doxford engines in three ships, aggregating 12,366 i.h.p. Special interest attaches to the machinery of the "Asia," which affords the first example of the new Richardsons Brown Boveri design of geared turbine machinery, of which we hope to give further details later.

Other North-East coast outputs included those of William Doxford and Sons, Ltd., of Sunderland, which firm built fifteen engines for motor vessels, eight of which were completed by the firm at the Pallion Yard, totalling 56,366 gross tons. The fifteen engines totalled 58,020 i.h.p. and included single-cylinder units of 3800 i.h.p., 2860 i.h.p. and 5850 i.h.p. output.

At the Wallsend Slipway and Engineering Company, Ltd., of Wallsend, machinery of the single and twin-screw geared-turbine type was constructed for four ships, aggregating 33,100 i.h.p.

During the year, 375 oil-burning installations were supplied, representing 479,500 h.p. At this yard and works a considerable amount of repair work to thirty-six ships was carried out, including damage and other surveys, and nine trawlers were converted from minesweeping to fishing and the machinery overhauled. The St. Peter's Works of R. and W. Hawthorn Leslie and Co., Ltd., were employed on seven sets of machinery, mostly oil engines, totalling 32,300 b.h.p.

At the Neptune works of Swan, Hunter and Wigham Richardson, Ltd., seven sets of engines of the Swan, Hunter-Doxford type and single-screw engines with a Bauer-Wach exhaust turbine of Swan, Hunter design were completed, aggregating 45,000 i.h.p., to which a total of eleven Bauer-Wach exhaust turbines have to be added, bringing the total to 54,870 i.h.p.

The Parsons Marine Steam Turbine Company, Ltd., of Wallsend-on-Tyne, completed 80,000 s.h.p. of marine geared turbine machinery and manufactured a further 80,000 s.h.p of mechanical gearing for other companies, to be used with geared steam turbines. Further, a total of 34,580 s.h.p. of gearing was cut.

On the Clyde, at the works of the Fairfield Shipbuilding and Engineering Company, Ltd., a large amount of gearing was cut, and during the year American gear-planing machinery was installed for finishing gear teeth. All this machinery operates in air-conditioned rooms, maintained at an even temperature.

At the Linthouse yard of Alexander Stephen and Sons, Ltd., three sets of 8000 s.h.p. geared turbine machinery and one set of Stephen-Sulzer oil engines were built, aggregating 27,200 s.h.p. In addition, 50,000 b.h.p. destroyer turbines were completed. At Barclay Curle's engine works eight sets of the Barclay Curle-Doxford oil engines were completed, which with 31,401 h.p. of Bauer-Wach turbine machinery for other ships and engine builders totalled 40,690 i.h.p., and twenty-two boilers of 19,865 i.h.p. total were constructed for other builders.

Cammell Laird and Co., Ltd., of Birkenhead, finished seven sets of single and double-geared turbines and one set of Doxford oil engines, totalling 48,600 i.h.p.

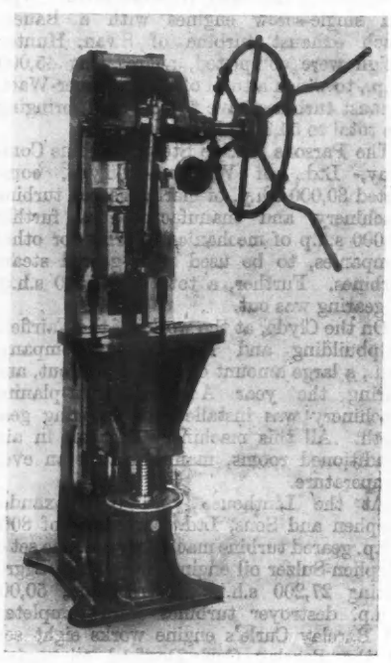
The annual returns of Harland and Wolff for the company's Belfast and Govan yards, show that during 1946 nineteen ships, totalling 180,574 gross tons, were launched. This is the largest total achieved by the company since 1914, when the highest figure of 182,759 gross tons was recorded. The output of main propelling machinery form the company's engine works at Belfast and Glasgow, amounted to 310,190 i.h.p., which constitutes a new record for the company. To this impressive total Belfast contributed no less than 288,290 i.h.p. Excellent as these figures are, it is pointed out that they are not representative of the total volume of work carried out during the year, as a considerable part of the firm's facilities and labour force was employed on a large programme of reconditioning work.

(*To be continued*)

Work at the Royal Ordnance Factories

IN view of the urgent demand for productive capacity and plant, it is a matter of some regret that the facilities available at the twenty-two Royal Ordance Factories being retained open in this country have not hitherto been publicised to a far greater extent. Many firms, particularly in the engineering and allied industries have been seeking, with but little success, for reliable sub-contractors with whom they could place orders for urgently required components and plant to supplement their own restricted capacities. It is now evident from the R.O.F. Exhibition, which closes on Jan. 18th in London, that for some time these Government-controlled establishments have been producing a variety of components and plant for industry and that there is still quite a large amount of capacity available.

This exhibition, which, we understand, is to tour the country, shows manufacturers what



FABRICATED CERAMICS PRESS

is being and what can be done in our many ordnance factories still having plant and personnel available. In these factories there is installed a quantity of precision and high-class production plant capable of a wide range of application and in most cases having available a good nucleus of skilled and semi-skilled labour. The fact that these factories will only manufacture to the requirements of existing trade concerns and do not produce goods for the open market alleviates any suspicion of eventual trade competition backed by Government resources. It is pointed out that production is not subsidised and all work is priced and carried out on normal commercial costing and production lines. Machines and components are sold only to their parent production firms at prices comparable with those which appertain in their own shops.

The exhibition although restricted in scope owing to space limitations is very well organised, and the methods adopted for illustrating the transition from war to peace production are effective and interesting. The variety and high quality of the products are particularly enlightening to those who regard Royal Ordnance Factories as establishments suitable only for the production of war requisites.

Not only is it shown that productive capacity is adapted and used for the manufacture of new goods, but also how a variety of the things such as explosives and shells left over from the war are being converted and re-used in other forms. This is particularly evident in the chemical section of the exhibition, where it is shown that ammonium nitrate, which was produced in large quantities for the manufacture of explosives, is now made for use as a fertiliser. T.N.T. has little potential for recovery, but it is being burnt and the residue, as carbon black, will be available to many branches of industry. Formaldehyde and hexamine, hitherto produced for the manufacture of R.D.X. explosives, are now being supplied for use in the preparation of medicines and plastics. Much gunpowder was left over from the war and from this is being recovered the potassium nitrate for commercial use. C.S.A.M., a smoke screen mixture, is being broken down to its main constituents, hydrochloric and sulphuric acids. A large battery of individual cordite sheet rolling mills have been rearranged and are now rolling powder composition for the manufacture of considerable numbers of gramophone record blanks a week.

It is in the engineering sections of the exhibition that the potentialities of the factories are most evident. The experience acquired over years of producing quantities of precision parts for guns, shells, fuses, &c., has obviously found little difficulty in adapting itself to commercial requirements. A brief list of the products to be seen at the exhibition is evidence of the breadth and scope of the facilities available. These products include woodworking machines and machine tools, railway wagons, refrigeration plant, electric and gas cookers, water taps and similar fittings, ceramics for fuses, switchgear, &c., milk bottle stoppers, gauges, tools, cutters, hobs, fabricated metal bodies of all kinds, clock parts, watchmakers' lathes, clock mechanism assembly fixtures, petrol engines, &c.

In addition to effecting a large number of railway wagon repairs, certain of the factories are making 16-ton steel goods wagons in large numbers. We were informed that at Woolwich Arsenal alone some eighty-five of these steel wagons are being assembled each week on one shift alone and that two other establishments are also manufacturing these vehicles in increasing numbers.

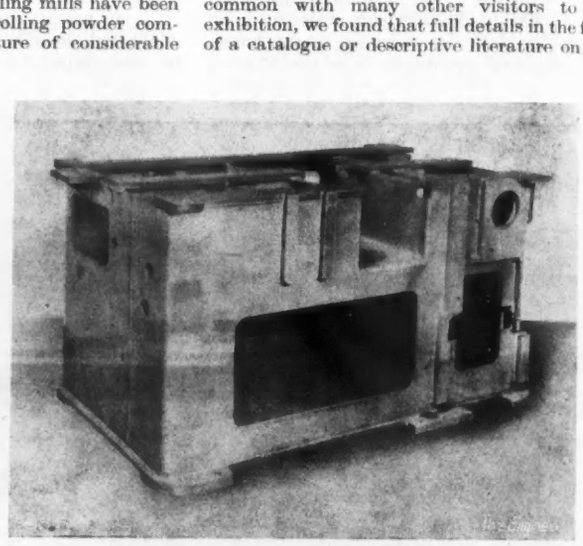
For the first time certain parts of oil well boring equipment are being built in this country at ordnance establishments, and in this connection the many years of experience acquired in the manufacture of long gun barrels has proved invaluable.

It is interesting to note how the considerable amount of experience gained in the fabrication of field ordnance carriages, gun mountings, &c., has now been turned to good use in the manufacture of machine tools, woodworking and other machines. A fairly large number of the machines now being made for trade manufacturers were on show with fabricated steel bodies instead of the usual iron castings. The adoption of this form of construction not only saves much time, but also relieves to a certain extent the heavy demands on foundries already overloaded with work. Particularly good instances of this class of work are an all-welded press and a woodworking machine body to be seen in the photographs we reproduce. This press was built in an ordnance factory for the production of ceramic components and does not incorporate any castings. A widely representative selection of fabricated plate work of a similar nature is to be seen on the various stands, and these serve to show how the extensive use of castings in many classes of work may be eliminated.

In order to produce the variety of small gear wheels for clock mechanisms a special gear cutter has been designed and built for this and similar classes of work in a factory hitherto engaged upon the manufacture of clockwork fuses. The same factory is also making a neat little watchmakers' lathe and a range of clock mechanism assembly jigs.

Other factories engaged on the filling of projectiles during the war are now making prefabricated concrete parts designed for rapid assembly into dwelling-houses.

The exhibition serves to show how the facilities of the ordnance factories are already being used to the benefit of industry and the country as a whole, and it is to be hoped that the remaining capacity which, we understand, is available will eventually be used to its fullest extent. In conclusion we must say that, in common with many other visitors to the exhibition, we found that full details in the form of a catalogue or descriptive literature on this new feature of ordnance factory working were not available. This lack of suitable literature should be rectified, as it will probably restrict in no small measure the full use of much valuable productive capacity.



FABRICATED MACHINE BODY

GERMAN TECHNICAL INFORMATION.—In a recent joint statement, Sir Stafford Cripps, President of the Board of Trade, and Mr. W. A. Harriman, United States Secretary for Commerce, announced additional arrangements for the exchange of German technical information acquired by the two nations since the end of the war. These arrangements are complementary to those already in force, whereby reports on German industry and technical developments, prepared by British and American investigators respectively, are made available to the industrialists of both countries. Hundreds of thousands of important German scientific and technical documents have been uncovered by British and American investigators in their respective zones, and microfilm copies have been made. Under the present agreement representatives of each nation will be able to select from each other's storehouse of reports the items which it finds valuable. Copies will be obtained on an exchange basis. The American depository for German documents and microfilms is the Office of Technical Services, Department of Commerce. Three British experts are now examining the catalogues and abstracts of these reports which have been prepared, and the Department of Commerce has agreed to provide microfilm copies of all items chosen by the screeners. In London, the main processing centre for German documents is the Board of Trade, German Division (Documents Unit). Microfilm copies of all documents desired by the U.S. Office of Technical Services will be supplied by the Board of Trade.

The Electricity Bill*

THE purpose of the Bill is to provide for the co-ordination under public ownership of the electricity supply industry in Great Britain.

A British electricity authority (hereinafter referred to as "the Central Authority") is to be established to maintain and develop an efficient, co-ordinated and economical system of electricity supply for all parts of Great Britain, except the North of Scotland district, established under the Hydro-Electric Development (Scotland) Act, 1943 (hereinafter referred to as "the Act of 1943"), as modified by the Bill, for which special provision is made. The Central Authority is to have power to generate electricity for supply in bulk to Area Boards and to distribute electricity to consumers in certain exceptional cases. Fourteen Area Boards are to be established whose duty will be to acquire supplies of electricity from the Central Authority and to distribute such supplies in their areas.

A duty is laid on the Central Authority to conduct research and on that Authority and the Area Boards to make provision for training employees.

In the North of Scotland district, the North of Scotland Hydro-Electric Board constituted under the Act of 1943 (hereinafter referred to as "the North of Scotland Board"), whose powers with regard to the generation of electricity by water power are to extend to the generation of electricity by any other means, will exercise both the functions of the Central Authority and of an Area Board.

The policy of the above-mentioned Authority and Boards will be directed to securing, *inter alia*, the cheapening of electricity supplies so far as practicable, the simplification of methods of charge, and the standardisation of systems of supply and types of electrical fittings.

The Minister may give to the Central Authority, and the Secretary of State may give to the North of Scotland Board, directions of a general character in relation to matters appearing to him to affect the national interest. The Central Authority may give such directions as it thinks necessary to Area Boards for the purpose of co-ordinating the distribution of electricity and exercising general control over the policy of Area Boards.

A Consultative Council is to be established for the area of each Area Board and for the North of Scotland district. These Councils will be appointed by the Minister, or in the case of the North of Scotland district by the Secretary of State, from amongst members of local authorities and representatives of consumers of electricity and of others interested in the development of electricity. It will be the duty of a Council to consider any matter affecting the distribution of electricity in its area and to notify conclusions to the Area Board, or in the case of the Council for the North of Scotland district to the North of Scotland Board. A Council has the right to make representations to the Central Authority, after consultation with the Area Board concerned, on matters which it has brought to the notice of the Area Board. In the case of the North of Scotland Board, such representations are to be made to the Secretary of State. A Consultative Council may prepare, and after approval by the Minister or the Secretary of State, as the case may be, put into effect a scheme for the appointment of committees or individuals to be local representatives of the Council.

On a date to be appointed by the Minister, all the assets and liabilities of the following bodies :—

(1) Authorised undertakers, *i.e.*, bodies authorised to supply electricity under the Electricity (Supply) Acts, 1882 to 1936, including the Central Electricity Board, but excluding the North of Scotland Board ;

(2) Power station companies, *i.e.*, companies which are not authorised undertakers, but whose business consists wholly or mainly in constructing, owning or operating a generating station or stations ; and

(3) Holding companies which are not authorised undertakers, but three-quarters of whose assets at the date of the last audited balance sheet of the company before January 1st, 1946, comprised interests in authorised undertakers or power station companies, will vest as follows :—

(*a*) In the Central Authority, the assets and liabilities of the Central Electricity Board, power station companies and holding companies, together with all generating stations and main transmission lines and assets and liabilities relating thereto, and all investments and cash of any authorised undertakers, other than such as vest in the North of Scotland Board ;

(*b*) In the Area Boards, all the remaining assets and liabilities of authorised undertakers other than such as vest in the North of Scotland Board ;

(*c*) In the North of Scotland Board, all the assets and liabilities of power station companies and authorised undertakers in the North of Scotland district, and all the assets and liabilities of holding companies whose interests are wholly or mainly in that district.

Provision is made for subsequent adjustments as between the Central Authority and the various Boards. Where the authorised undertakers are a local authority only the electricity undertaking will vest.

The holder of securities in any body, other than a local authority, whose assets and liabilities are transferred by the Bill, is to be compensated by the issue to him by the Central Authority of British electricity stock of such amount as in the opinion of the Treasury is of a value equal on the date of issue to the value of the securities.

Local authorities are to receive by way of compensation for the transfer of their electricity undertakings payments from the Central Authority to cover the interest and sinking fund charges on the debt of such undertakings.

It is to be the duty of the Central Authority to secure that the combined revenues of the Central Authority and the Area Boards are not less than sufficient to meet their combined outgoings properly chargeable to revenue account, taking one year with another. The North of Scotland Board is already under a similar obligation under the Act of 1943. The Central Authority is to be given general powers of control over the policy of Area Boards in financial matters.

The Central Authority is to be required to establish a central reserve fund, which can only be used for the purpose of the Central Authority and the Area Boards, and to which the Authority and the Boards are to contribute. Any Area Board may establish an area reserve fund, to be used only for the purposes of the Board and to be built up only out of the surplus revenue of the Board. One of the purposes of the central and the area reserve funds is the prevention of frequent fluctuations in charges for electricity.

A duty is imposed upon the Central Authority to supply electricity to any railway undertaking for haulage or traction, and where so supplied, the railway undertaking may, with the approval in writing of the Authority, use the electricity for any other purpose. Area Boards are not to give such supplies without the approval of the Central Authority.

The Central Authority is to be required to investigate methods of using surplus heat from generating stations and that Authority or any of the Boards is to be empowered to make use of, or to assist others in making use of, such heat.

Power is given to the Minister by Order to dissolve the Electricity Commissioners and to transfer their property, liabilities and function to other bodies or persons.

The Minister is to be empowered to make regulations for securing the regularity and efficiency of the supply of electricity and the safety of the public.

* Extracts from the Explanatory Memorandum accompanying the Bill.

Road Building in the United States

ROAD construction reached the surprisingly low figure of 2964 miles in the United States in the year ending with June, 1946. This compares with 4011 miles for 1945, and was composed of 991 miles on the main or Federal-aid highway system, 294 miles of secondary roads, 1673 miles of roads giving access to war plants, and 6 miles miscellaneous construction. Of level crossings, 29 were eliminated. The total cost was £26,000,000, of which 74 per cent was paid by the Federal Government. Plans were approved for 11,450 miles in 1946–47, as against 2730 in 1945, but construction is hampered and halted by unsettled economic conditions, high prices, shortage of materials and machinery, shortage of engineers and technical men, and especially the labour situation. As a result, contractors are apt to bid high prices, to insure themselves against loss, but this reacts in the rejection of proposals as excessive. Progress was made in the designation of the authorised 40,000 mile network of main highways, of which 5000 miles are to be expressways passing through cities. Supplementing this network will be a network of secondary or farm-to-market roads, and the city expressways will be supplemented by circumferential or by-pass roads to permit through traffic to avoid cities. These by-passes would be largely for truck traffic, as surveys indicate that automobile drivers usually prefer to go through the cities. Another matter, to be dealt with later, is the provision of safety turnouts, resting places and parking areas along the roads, and also the landscaping of the roadsides for the pleasure and convenience of travellers. Surveys of traffic capacity indicate a maximum of 500 vehicles to 700 vehicles per hour per lane on streets, but on expressways, it may run from 1200 to 1500 vehicles. Weights and wheel-loads of motor-trucks or lorries continue to increase. Besides new construction, there is a great mileage of damaged and worn paving to be repaired.

Technical Reports

Road Research Special Report No. 3 : *Roadstone, Geological Aspects and Physical Tests.* H.M. Stationery Office, price 9d.—The report is the result of collaboration between two organisations of the D.S.I.R.—the Geological Survey of Great Britain and the Road Research Laboratory. Modern methods of road construction and the almost universal use of pneumatic tyres permit road builders to employ a far wider range of roadstones than was possible in the days of water-bound macadam and iron-shod traffic. By far the largest part of the output of British quarries is consumed as roadstone and ballast, and in 1938 more than 24 million tons were so used.

In the report the essential facts concerning the geology and petrography of roadstones are concisely stated. The fundamental differences between the main classes of rocks are described and the bearing of the nature of the rock and of the geological structure on the development of quarrying operations is explained. The mineral composition, texture and general characteristics of the principal rock types are considered. The section on physical tests includes brief descriptions of the British Standard tests on roadstone. The results of tests on about 1200 samples of roadstone are analysed and used as the basis of a discussion on the following aspects of physical testing :—(*a*) Reproducibility of results, (*b*) correlation between the results of different tests, between the results of physical tests and petrographical examination, and between test results and service behaviour of the aggregates. The properties desirable in aggregates for particular forms of construction (concrete, bituminous, &c.), are discussed.

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NOTICE TO READERS

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NATIONALISATION OF ELECTRICITY

IN the proposed nationalisation of the iron and steel industry and of inland transport it can justly be contended that no convincing evidence has been brought forward to show that centralised monopolistic control could and must lead to greater efficiency. But that argument cannot be applied against the nationalisation of electricity supply. For only by linking together all the main generating stations in the country and operating them to a national plan can continuity of supply be ensured and maximum economy in the cost of generation be attained. In such circumstances it cannot be deemed illogical to nationalise generation and transmission and the further step to extend public ownership also to local distribution is not a long one. In effect, indeed, electricity is already generated and transmitted under national control as a result of the operations of the Central Electricity Board. Moreover, its distribution lies to a considerable extent in the hands of municipal, public bodies. These facts make the Electricity Bill presented to Parliament last week one of the less contentious of the Government's nationalisation measures, despite the fact that the independent private supply companies hotly oppose nationalisation.

By the terms of the Bill, as will be seen from a summary on another page of this issue, a British Electricity Authority is to be set up "to maintain and develop an efficient co-ordinated and economical system of electricity supply." That authority will take over the generating stations and will also exercise very much the same functions as the existing C.E.B. Distribution of electricity, as opposed to its generation and transmission over the grid, is to be placed in the hands of fourteen Area Boards, whose operations will be co-ordinated and supervised by the Authority. In the Highlands, a special condition will rule in that the existing North of Scotland Hydro-Electric Board will perform jointly the functions both of the Authority and of an Area Board. Little objection can be taken to the policy laid down in the Bill for the guidance of the new Authority. It is "so far as practicable" to cheapen supplies of electricity, to simplify methods of charge for supplies and to secure standardisation of systems of supply and types of electrical fittings. Such policies have been followed for many years by electricity companies, municipal concerns and the C.E.B. The new authority, however, ought to be in a better position to co-ordinate and facilitate the work owing to its greater range of control over every aspect of electricity supply. Moreover, in the standardisation of voltage and of types of electrical fittings over the whole country a single control authority has an obvious advantage financially and in other ways over a multiplicity of smaller concerns who may find difficulty in reaching agreement. A similar advantage may be found to rule in the field of research so long as the new authority and its Boards manage to avoid that conservatism that often afflicts very large concerns in the absence of competition. It is specifically laid down in the Bill that the authority shall "investigate methods by which surplus heat from generating stations may be used for the heating of buildings in neighbouring localities and for any other useful purpose," and it is also, more generally "to conduct research into matters affecting the supply of electricity and to assist other persons conducting such research." No mention appears in the Bill of the policy the authority is expected to follow in simplifying charges. Presumably within each Board area single systems of charge will replace the varying systems and scales of the many existing distributing concerns. But no clue is provided as to whether the Authority is intended to aim at a standard method and scale of charge applicable all over the country. That point is of some interest and importance to outlying rural districts, which seem unlikely to be able to benefit from cheap electricity supplies unless subsidised in some such manner. It is, too, a matter of some concern to certain urban areas in which, as a result of efficient handling in the past, low rates for supplies at present rule. For standardisation of charges over wider areas would presumably react unfavourably on those low rates.

The weakness of all great monopolistic bodies, whether national or private, is that they inevitably become insensitive to merely local needs and that it is difficult to devise machinery that will bring home to them how really important those needs may become. Under the Bill, consumers of electricity and "other persons or organisations interested in the development of electricity" will be represented on Consultative Councils for each area. Representatives of local authorities will also sit on these Councils. It remains to be seen, however, if and when the Bill receives the Royal Assent, whether these somewhat large bodies representative of wide areas will be able to represent adequately those smaller areas of supply at present catered for by companies and municipalities. Nevertheless, despite the less intimate contact between consumer and supplier that seems likely to arise—a no small disadvantage of nationalisation—it does seem that there is some justification for the Government's policy of bringing the industry into public ownership. But is there so much justification that the change must be made immediately? We find that far less easy to believe. Supplies of fuel are scarcely adequate and variable in quality and the country is seriously short of generating capacity and will be so for some years to come. The over-riding need at present, surely, is that attention should be concentrated on the efficient maintenance and operation of the plant available. Are these the circumstances in which so profound and disturbing a re-organisation of the management of the industry as is implied by the provisions of this Bill can best be undertaken?

TOWN AND COUNTRY PLANNING

IT has for several years now been generally admitted that the powers available to the Government and to local authorities to secure the orderly and satisfactory development of urban and rural areas in accordance with changing needs have not been sufficient. Broadly, criticism of the existing system is based upon the grounds that though it can usually prevent bad development, it can secure good development only with difficulty and delay; and that even in relation to the prevention of undesirable changes, it is not wholly satisfactory. For though the powers are there with which to control, for instance, ribbon development or to reserve land for parks and green belts, they often cannot be used because the compensation payable as a result of using them would be beyond the means of the authority concerned. It is the object of the new Town and Country Planning Bill, which was issued last week, and whose measures are clearly founded upon the recommendations of the Barlow, Scott and Uthwatt Reports, to correct the defects of the existing system, to ensure that planning control is applied to the whole country and to provide for the co-ordination of planning over large areas.

The terms of the new Bill were announced in our last issue and need no reference in detail here. It should be noticed, however, that responsibility for planning is to be transferred from local to county councils in order to secure regional rather than local planning and that wider powers for the compulsory acquisition of land and for carrying out work for themselves are to be conferred on local authorities. Further, the value of land to an owner is henceforth to be restricted to that corresponding to its existing use. If development takes place by the erection of factories or houses or the conversion of houses into shops or by the working of minerals or in any similar way

likely to enhance the value of the site a "development charge" will become payable to a Central Land Board. This charge will not amount to more than the estimated increase in site value and may sometimes be less. In effect, an individual or a firm buying land for the purpose of development will pay about as much for it as at present; but part of that payment will be made to the Board and the original owner will get only the amount corresponding to the value of the site for its existing use. Clearly, the work of engineers may be closely affected by some of the provisions of such a Bill. For town and country planning is not restricted only to housing. All kinds of public and private works in the design and building of which engineers are concerned will be involved. Civil engineers and contractors and those many engineers in local government service and in the employment of large authorities such as catchment boards, water boards, &c., which are responsible for carrying out many important works may well feel sympathetically inclined towards a Bill which promises some simplification of the present difficulties of realising plans. For work upon great and desirable schemes can often be hindered and delayed by the refusal of owners to sell land or by demands for inflated compensation or by differences of opinion between the smaller local authorities as to sites, or other details, all of them troubles for which the Bill provides remedies. But it is not civil engineers alone that are affected by the new measure. The industrialist and those dependent upon his prosperity for a livelihood are in a rather different position. For the Bill certainly appears to place in the hands of local authorities the power not only to forbid or permit further expansion of a works, but, through their planning organisations to settle, at least in broad outline, the actual distribution of industry. For once plans for the whole country have been prepared—and the duty is laid upon planning authorities to prepare plans in broad outline for the whole of their areas within three years—it seems that it will be impossible to go ahead with the erection of works or the working of minerals, &c., without obtaining the permission of the local authority and consulting the Land Board as to the development charge payable. It may well be asked, therefore, whether the new Bill will not add still further to that aggravating load of paper work that industry now has to carry; whether negotiations before work can be started will not be further complicated; and whether there will not be a yet further addition to the numbers of those already in unproductive departmental employment? Is such complete control extending over the whole country necessary and desirable? Was it realised when the great plans for the development of London and Greater London and of Merseyside and several others were published and won the very general approval of the public how great a degree of control would be deemed necessary to carry them out?

This new Bill raises issues, more particularly perhaps those concerned with compensation and betterment, which are highly controversial and which have in the main little to do with engineering. It is, in fact, probable that it will be upon these controversial issues rather than other matters more directly the concern of engineers that the fate of the Bill will be decided. Thus engineers may feel, so far as political passions roused by the Bill will allow, that it is less for them to say whether they think the Bill should be accepted or rejected than to secure rather the amendment of any of its clauses that may be found upon examination to bear unduly hardly upon their interests. Yet it is scarcely possible to maintain such complete detachment. We, ourselves, find a certain difficulty in envisaging the consequences of the passage of the Bill without some feeling of trepidation. For a very heavy responsibility for the future welfare of this country is to be laid upon the planning bodies under this Bill. If in planning development due allowances are made for the varying needs of industries and sufficient flexibility is permitted to provide for those changes that the passing years are bound to bring, all may be well. If not, in the execution of some great scheme of so-called improvement, popular with the lay public, it may well happen that industry—that goose which lays the golden eggs upon which our future prosperity is founded—may be discouraged. How far, we wonder, is the public really capable of appraising the merits and faults of great plans of development; and the relation between the advantages to be attained by such plans and the cost in convenience and flexibility, as well as in money, of carrying them out? Can local authorities, we wonder, always be trusted to be wise?

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"LOCOMOTIVE BOILER PRESSURE"

SIR,—I read with much enjoyment Mr. Tuplin's most interesting article under the above heading in your issue for December 27, 1946.

There is one small point upon which I would like to comment. Mr. Tuplin says: "The characteristic of the Stephenson gear in giving negative lead in full gear makes it preferable for starting and low speed running." That is not strictly correct, for there must still be many locomotives running in this country fitted with Stephenson's (or more correctly, I suppose, Howes') link motion which do not have negative lead in full gear but positive lead. Negative, line and line, or positive lead is with "Stephenson's" as with any other gear merely a question of valve setting. Speaking without the book, I believe that the late Jackson Churchward was the first to introduce a valve setting (with Stephenson's gear) giving negative lead in full gear, a setting which so far as I know, is in force to-day on the G.W.R.

What Mr. Tuplin evidently had in mind is the *increasing advance* which the Stephenson gear gives to the valve as the gear is linked up; this, of course, is only true of "open" excentric rods; "crossed" rods have precisely the reverse effect, but so far as I know are never used in locomotive practice. The shorter the proportional length of the excentric rods, the greater the amount of this increase in advance, and it is an extremely valuable feature of the Stephenson gear. It is probably true to say that a well-designed Stephenson gear—using the launch type of link (as is used largely on the G.W.R.) will, for a given cylinder and boiler pressure, give a higher power output than will any other gear in common use.

One of the characteristics of modern locomotive design is the comparatively small amount of lead given to valves operated by Walschaerts gear (in which, of course, the lead is constant for all points of cut-off), this being of the order of one-thirteenth of the lap, thus $1\frac{1}{8}$in lap, $\frac{1}{8}$in lead, whilst modern setting for long travel launch type link, Stephenson gear, will have $\frac{3}{16}$in *negative* lead in full gear. This is very different indeed from the setting in vogue in the early years of this century when full-gear leads were usually of the order of $\frac{1}{8}$in to $\frac{3}{16}$in, with a valve travel of 4in or sometimes less.

The late William Stroudley's famous "Gladstone" class 0–4–2 engines were amongst the most efficient of their day, and it may be significant that though the valves had (according to modern ideas) short travel, they had only $\frac{1}{16}$in lead in full gear, an unusually small figure for the period.

It is significant that for two-cylinder engines, Mr. Churchward never used any other gear than Stephenson's, and his successors have followed that practice, right down to Mr. Hawksworth's new "1000" class. I think it would be true to say that Mr. Churchward's work on valve gears probably contributed more towards the improvement of British locomotive performance than anything else in the present century, as it certainly is true to say that it is only of recent years that its full implications have come to be appreciated.

K. N. HARRIS

Harrow, Middlesex, January 9, 1947.

OVERTIME IN THE DRAWING-OFFICE

SIR,—May I request the courtesy of your columns to give my views on the question of overtime in drawing-offices? At one time I thought I was the victim of my own anti-overtime complex, but since being with my present firm, which is not in favour of late work, I have seen in the contented mood and good health of the staff a sound reason why overtime should not be worked.

Overtime in drawing-offices falls into two categories—the brief spell and the systematic. Few will object to the former, since it helps the firm in a genuine difficulty. The latter is, however, a different kettle of fish, and may, and generally does, go on for months.

During a prolonged spell of overtime the efficiency of the draughtsman falls to a very low level. It always amazes me that employers and their executives fail to see this, as they are, to my mind, simply throwing their money away. But, strange to say, they prefer to await an impending revolt of the staff rather than call a halt.

Some firms have such a reputation for overtime that it is considered their normal working procedure. Only when work becomes slack do they revert to the ordinary working hours. One such firm allowed me a week's "grace" to settle in. Thereafter I did three and four "nights" a week for fifteen months, working till 9 p.m. each evening.

It is ironic to see draughtsmen on overtime

taking to tonics to keep up their strength, when all they need is their normal quota of sunshine and fresh air. One cannot escape the penalties of being cooped up for entire days in a badly ventilated atmosphere, and of using up reserves of nervous energy. Coming out late from an office on a fine summer evening and hearing the shouts of cricketers and tennis players on adjacent recreation grounds gives one food for thought. I have worked in some interesting towns, places noted for their architecture and lovely surrounding country, but, alas! those fatal "three nights a week" intruded all too soon, leaving me with few impressions but those of four walls as viewed from an armchair.

Of the social implications of overtime, what about the home life of the overtime-working draughtsman? Can he be said to be a fit companion to his wife and a responsible parent to his children on those nights he fails to arrive home until 9.30 p.m.? For half the week, one may say, he is absent from home over a period which may last for months.

Finally, there is one other point. Why is it that veiled intimidation is used when individual draughtsmen seek to avoid overtime? These men are not lazy; in many cases they are the hardest workers in the office. But they have the good sense to know that by working hard over the normal day, they are utilising their energy and talents to the best advantage.

That is the real point at issue. And when all employers realise it, perhaps we shall see as an addition to the "Wanted" advertisements, "Overtime entirely optional."

DRAUGHTSMAN.

January 11th.

CONDENSING BY COMPRESSION

SIR,—Having been away from my London office for some time, I have not followed up the further correspondence which has ensued on the above subject, and therefore my reply to the points raised is somewhat overdue.

Attempts to explain the reason for the collapse of the exhaust steam under the conditions prevailing in the experimental plant have always aroused controversy, and it has been my experience over a number of years that any theory set up is at once assailed as being at variance with the accepted theory of steam. In my previous letter I raised the query as to whether the impurities in the steam used, more particularly the lubricating oil, brought about this collapse, and, not unexpectedly, it has been answered very decidedly in the negative.

Your correspondents suggest that I should produce a heat balance of the system. Such information would have been given in the article on the subject had sufficient data been available. The tests in which I was interested were comparative fuel tests and the overall results were expressed in pounds of coal per kilowatt-hour, few records being made of events in the intervening stages.

Although actual figures are not available, it might be possible to construct an approximation to a heat balance from general knowledge of the plant, and that is a matter which I will investigate.

H. HOLCROFT,

Chipstead,
Surrey,
January 4, 1947.

REMUNERATION OF ENGINEERS

SIR,—Having, only recently, read the large number of letters on this subject, I am mildly shocked to see that people, holding engineering degrees, demand such high salaries so shortly after leaving the university. On graduating it is silly to believe that one is a trained engineer; far from it, for one is then only qualified to teach or carry out research. It is only after ten years' practical experience in industry that one begins to understand fully the many complications of efficient design and production.

A large part of this ten-year period should be spent in doing practical work in the workshops themselves; this is the only way of appreciating the difficulties incurred in manufacture and the capabilities of the machines used.

Wages paid during such training are low, but, while appreciating that everyone must live, it is only after experience of this kind, coupled with an average amount of commonsense, that success is achieved.

Anyone can earn a good salary in their particular line if they are prepared to work hard and if initiative is used when young, later one need have little to fear.

D. C. Y. HIGGS,

Hockley Heath, Warwickshire,
January 13th.

SIR,—If a man studies engineering science he should expect to increase his knowledge not his income. If he considers it more important to increase his income, he should divert his attention to the study of that subject. It is an art in which engineers generally appear to have little skill. To assume any connection between the two is either to exhibit a touching but very unworldly faith in the reward of virtue, or to display some muddled thinking which is a discredit to the profession.

JOHN A. R. FIFIELD

London, S.E.18, January 11, 1947.

An Agricultural Engineering Merger

AT the recent annual general meeting of Marshall, Sons and Co., Ltd., Gainsborough, Mr. Ashley S. Ward, the chairman of the company, announced that a merger between the Marshall undertaking and the firm of John Fowler and Co. (Leeds), Ltd., has been completed. £200,000 of the ordinary capital of the two companies will be exchanged, and Mr. C. W. Hayward, chairman of John Fowler, and Captain E. N. Griffith, deputy chairman, will join the Marshall board and certain Marshall directors will join the Fowler board. The step taken, Mr. Ashley S. Ward went on to say, would enable the Marshall company to increase materially the output of the Field Marshall heavy wheel diesel tractor, which is now firmly established, and is in great demand. The two old established firms, both nearly 100 years old, and both prominent in the oil engine tractor field, will pool their manufacturing design and selling organisations, thereby increasing efficiency and production for home and export trade. The combination of firms will continue to produce oil engines, oil-engined locomotives, threshing machinery, tea-preparing machinery, road rollers, and wire drawing machinery. The Sprotborough mechanised foundry acquired by John Fowler's from the Ministry of Supply, will be utilised by the group. Sprotborough is conveniently situated approximately half-way between Leeds and Gainsborough. With factories at Leeds, Gainsborough, Crook and Sprotborough, covering 50 acres, and ultimately employing 7500 work people, the firms so amalgamated will constitute one of the largest engineering groups of its kind in Europe.

CYCLE AND MOTOR-CYCLE SHOW.—The British Cycle and Motor-Cycle Manufacturers' Union announces that the first Cycle and Motor-Cycle Show since pre-war days will be held at Earl's Court, London, towards the end of October next.

Literature

SHORT NOTICES

Electric Wiring Theory and Practice. Eighth edition (revised). By W. S. Ibbetson, B.Sc., A.M.I.E.E., M.I. Mar. E. London: E. and F. N. Spon, Ltd. Price 10s.—In this new impression of his well-known book the author has extensively revised certain sections, including the first four chapters, and small alterations have been made throughout. Certain other minor corrections have been included in an errata sheet facing page 1, and it seems unfortunate that, while the revision was being carried out, these alterations should not have been incorporated in the text.

Practical Mechanics for All. By Leroy A. Beaufoy, M.Sc., &c. London: Odhams Press, Ltd., Acre Lane, W.C.2. Price 9s. 6d. net.—The wide field of practical mechanics that this book of about 450 pages covers is particularly ambitious, and the editor and team of authoritative contributors are to be congratulated in having condensed so much in a readily understood manner into so small a volume. The scope of the book may best be appreciated by the following list of its contents, with their authors:—"This Mechanical World," by Dr. L. A. Beaufoy; "The Mechanics of Equilibrium," by Dr. A. D. Ross; "Forces in Structures," by Dr. A. D. Ross; "The Mechanics of Movement," by A. T. J. Kersey; "Friction and Lubrication," by W. Marsh; "Practical Mechanisms," by J. L. Thomson; "Forms of Energy," by W. Marsh; "Strength of Materials," by Dr. W. Fisher Cassie; "Properties of Materials," by Dr. W. Fisher Cassie; "Machine Principles and Design," by J. L. Thomson; "Mechanics of Fluids," by Dr. B. J. Lloyd-Evans; "Hydraulic Machinery," by Dr. B. J. Lloyd-Evans; "Testing and Driving of Machines," by J. L. Thomson; "Mechanics of Flight," by H. C. Morris. Many students and others interested in general engineering will find this book interesting, instructive and entertaining.

Atlas of Defects in Castings. Series I. Manchester: The Institute of British Foundrymen, St. John Street Chambers, Deansgate. Price to non-members 10s. 6d. net.—This atlas has been prepared to assist ferrous and non-ferrous foundrymen in the correct recognition and classification of defects in castings. These defects are liable to be given various names which often lead to misunderstanding, and their incorrect diagnosis can result in much trouble and wasted effort in the foundry. As the collection of a comprehensive series of photographs covering the large number of defects which may exist in castings will take some time to complete, it is the intention of the Institute to publish this work in serial form as sufficient suitable examples become available. In this atlas each form of defect is clearly illustrated by an excellent engraving accompanied by a clear concise description, together with the causes of the defect and suggested remedies.

BOOKS RECEIVED

A Course of Reinforced Concrete Design. By Thomas J. Bray. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 25s.

Trigonometry Refresher for Technical Men. By A. Albert Klaf. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 25s.

Metallurgical Materials, Alloys and Manufacturing Processes. By V. N. Wood. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 25s.

Fuels, Combustion and Furnaces. By John Griswold. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 27s. 6d.

Mathematical Aids for Engineers. By Raymond W. Dull. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 22s. 6d.

Gas Turbine Development in 1946

No. III—(*Continued from page 54, January 10th*)

BRITISH THOMSON-HOUSTON COMPANY, LTD.

IN the year under review, the British Thomson-Houston Company, Ltd., of Rugby, has advanced notably in the direction of peacetime applications of gas turbine work from the pioneering work on the Whittle jet engine, which was initiated in 1936. The applications of the industrial type of gas turbine require a construction differing considerably from that used in jet engine technique. Weight in the industrial unit ceases to be the fundamental consideration, and long life, reliability and efficiency become of greater moment according to the application under consideration. The fields in which the B.T.H. company is principally concerned for the time being are, it informs us, marine propulsion, peak-load and power station generating plant, and locomotive applications. Whilst there are other useful spheres of application, such as blast furnace blowers and oil-field work, concentration has been directed to the three functions, above mentioned.

A promising start has been made on a gas turbine for ship propulsion, as already announced, for the Anglo-Saxon Petroleum Company, Ltd. Going through the shops at Rugby is a gas turbine of 1200 h.p. rating, which, in due course, will be installed in a tanker, and will form part of the main propelling machinery, working in parallel with diesel engines through a.c. transmission.

For this plant special attention has been paid to the actual space available in the ship, and to the consideration of a long operating life, with short lay-up times, which are characteristic of oil tanker operation. For these reasons, a simple open-cycle design has been chosen, without undue emphasis upon thermal efficiency, but the design adopted is such that the heaviest grades of boiler oil will ultimately be employed as fuel.

The propeller characteristics for ship propulsion are such that it is highly desirable for the air compressor to be driven independently of the output shaft, and as shown in the left hand drawing on this page, a two-shaft arrangement of turbine has been adopted.

The general mode of operation is as follows: Air enters the axial flow compressor and is compressed in it to a pressure of 40–60 lb per square inch gauge, a higher pressure being selected for larger turbine units. The air thus compressed is then passed through a heat exchanger, in which it is pre-heated by the heat transferred from the exhaust gases. The air which is under pressure and at a lower temperature and, therefore, has a considerably higher density than the exhaust gases, passes through the heat exchanger tubes. The pre-heated compressed air then passes to the combustion chamber, in which a portion of the air is utilised for combustion, while the remaining and larger portion is employed to dilute the combustion products, and so to reduce the temperature of the gas mixture to a desired value.

The gases from the combustion are first led to the h.p. turbine, which drives the air compressor, and they afterwards pass through the l.p. turbine which provides the useful output. On leaving the l.p. turbine the exhaust gases pass through the heat exchanger to the funnel. The power developed is transmitted electrically from the l.p. turbine, which drives the alternator, to the motor on the propeller shaft.

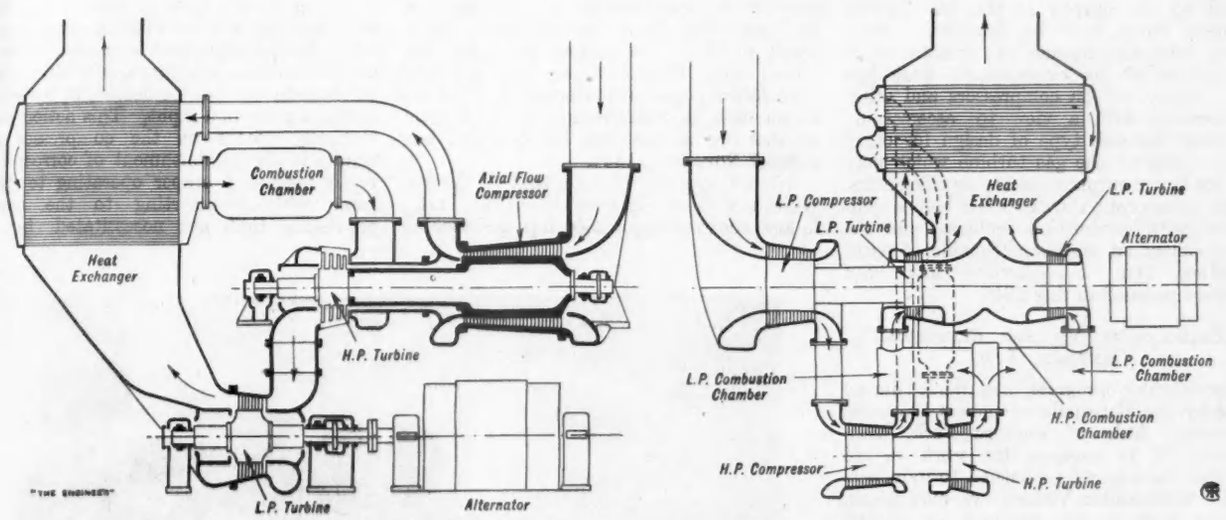
The division of the turbine into two cylinders, with the h.p. turbine driving the compressor and the l.p. turbine providing the propulsive power, is an arrangement which ensures a good starting torque, which is essential when manœuvring. At the same time, it gives an easy control of the propeller speed. The speed of the propeller, which is dependent on the output of the gas turbine unit, is controlled simply by the fuel supply, and it operates as follows. If the output is to be increased the initial gas temperature is increased, and as a result the output of the h.p. turbine, which leads to a speed increase of the h.p. turbine-driven air compressor. When the speed of the compressor goes up, however, both the quantity of air handled and its pressure will be increased, and the power absorbed by the compressor will also go up, so that the speed increase is checked when the speed corresponding to a new fuel lever setting is reached.

When the initial pressure and the gas quantity are increased the gas pressure at the h.p. turbine exit will be raised accordingly. The result of the increase in the fuel supply is, therefore, that the l.p. turbine obtains a larger gas quantity at a higher pressure, and that its output is increased accordingly. The h.p. turbine-compressor unit in combination with the combustion chamber may be regarded as a generator of gas under pressure, which serves as the working fluid in the l.p. turbine. The sole purpose of the heat exchanger is to reduce the consumption of fuel by increasing the temperature of the compressed air before combustion.

For larger powers and other applications, a more efficient cycle embodying inter-stage combustion would probably be adopted. The second drawing indicates such an arrangement. In this design, it will be seen that the air compressor is split into two cylinders. The l.p. compressor is driven by an l.p. gas turbine and the h.p. compressor by the h.p. gas turbine. Between the two compressors an inter-stage cooler, not shown in the drawing, may be fitted. Such an intercooler will improve the efficiency of the plant, while a further advantage is that the output per unit weight of air is increased, so that the size of the other components becomes smaller for a given output.

From the h.p. compressor the air is led to a heat exchanger, where it becomes pre-heated by the heat transferred from the exhaust gases. As in the layout previously described, the air passes through the tubes of the exchanger, the hot exhaust gases being on the outside. The pre-heated compressed air goes to the h.p. combustion chamber, and then passes through the h.p. gas turbine, which drives the h.p. compressor only. After passing through the h.p. turbine the gas is divided into two streams.

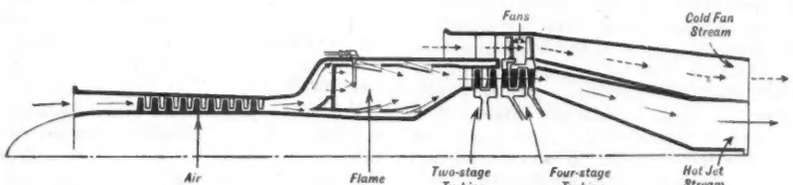
One goes through an l.p. combustion chamber, in which the temperature of the gases is restored to its initial value by the combustion of additional fuel, and it then passes through the l.p. gas turbine, which drives the l.p. compressor. The other flow passes through the l.p. combustion chamber and the other l.p. gas turbine which drives the alternator. The two flows join



GAS TURBINE GENERAL ARRANGEMENTS FOR SHIP PROPULSION

again behind the two l.p. turbines, and the exhaust gases pass through the heat exchanger to the funnel. In the exhaust gas passage behind the heat exchanger, an exhaust boiler may be fitted, but this is not indicated in the drawing. It will be seen that the two l.p. turbines are mounted on separate shafts so that the l.p. air compressor and the alternator may run at different speeds.

With an initial temperature of 1100 deg. to 1200 deg. Fah., and inter-stage reheat to the same temperature, an overall thermal efficiency of 25 to 30 per cent referred to the output at the gas turbine coupling flange may be obtained. Associated with the marine gas turbine order referred to above, experimental work has been carried out on compressors and other components with a view to ascertaining the most suitable type of design for other applications of the gas turbine which may call for larger outputs and higher efficiencies. Close collaboration with other bodies connected with combustion problems and the development of materials capable of withstanding high temperatures has been actively pursued during 1946.



FLOW PATHS THROUGH AUGMENTER TURBINE

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD.

Considerable progress was made during 1946 by the Metropolitan-Vickers Electrical Company, Ltd., of Trafford Park, Manchester, 17, in applying the work on gas turbines for aircraft propulsion to industrial uses. Metropolitan-Vickers, we may recall, started work on gas turbines for aircraft propulsion in 1938 at the request of the Air Ministry. That work is described on another page of this issue and in last week's issue on page 43 we illustrated the F2/4 Metropolitan-Vickers jet engine and briefly described it.

In parallel with the later stages of this development of jet propulsion engines, a ducted fan augmenter was designed, built and subjected to bench tests. That augmenter was virtually the first power turbine to be associated with a turbo type gas generator to be built by the company. Like other power turbines of this type, it was an independent turbine installed in the exhaust from the turbine driving the air compressor but its external load was in the form of fan blades instead of the more usual shaft drive to an external mechanical or electrical load. A drawing illustrating the flow paths through the gas generator and the ducted fan is reproduced herewith. It may be noted that the design of this augmenter turbine presented difficulties greater than would apply to the design of a more normal power turbine, in that it was of the contra-rotation type, and the turbine blading had to be designed to carry fan blades on the periphery of the blade rings. Moreover, weight had to be kept down to a minimum. Trials proved the mechanical design to be entirely satisfactory.

The first power turbines designed for a mechanical load instead of an aerodynamic load were two units, each with a designed output of about 2000 h.p., and these have been subjected to extensive bench tests with a dynamometer loading. The gas generator portion of these two units follows in general design that of jet engine practice. They were designed for the Admiralty and further details of these sets are likely to be released later.

At the annual general meeting of the Great Western Railway Company on March 6, 1946, Lord Portal, the chairman of the company, announced that the application of the gas turbine to rail traction problems was being investigated. As a result of the investigation, an order was placed with British Brown Boveri, Ltd., for a 2500 h.p. gas turbine electric locomotive to be built in Switzerland. A description of that locomotive will be found in our issue of Nov. 26th, 1946.

We are now able to state that the Metropolitan Vickers Electrical Company, Ltd., is also constructing a 2500 h.p. gas turbine electric locomotive to the requirements of Mr. F. W. Hawksworth, M.I.Mech.E., the Chief Mechanical Engineer of the Great Western Railway.

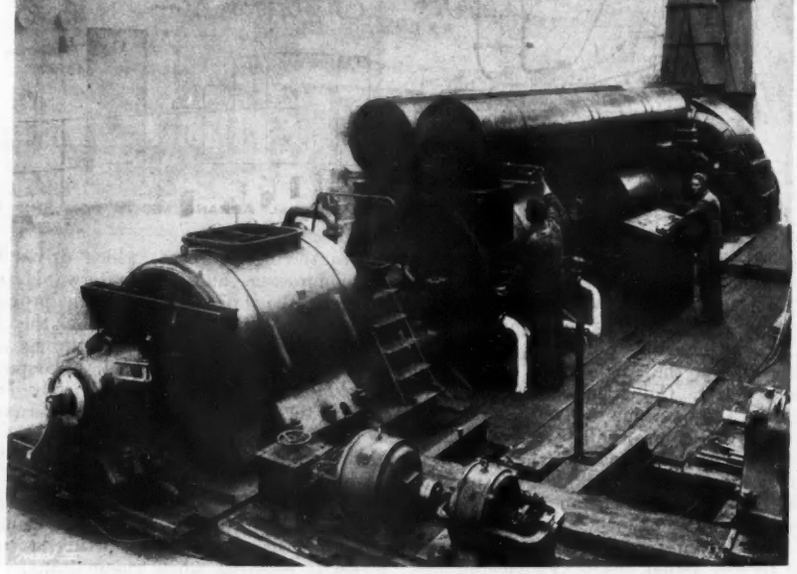
The leading particulars of the Metrovick gas turbine electric locomotive are as follows: Length over buffers, 68ft; bogie wheel base, 15ft; bogie centres, 39ft 6in; total wheel base, 55ft 6in; width of body, 8ft 10in; height above rail, 13ft; total weight, 120 tons; adhesive weight, 120 tons; maximum speed, 90 miles per hour; maximum tractive effort, 60,000 lb, and continuous rating tractive effort, 23,000 lb.

The locomotive is intended for hauling express passenger trains on the main lines from Paddington to Plymouth, Penzance, Bristol, Fishguard and Birkenhead. Such trains sometimes reach eighteen coaches in length, with a weight of 650 tons behind the engine, and the schedules require speeds up to 90 m.p.h. Sustained gradients of 1 in 80 are not uncommon and short gradients as steep as 1 in 40 have to be negotiated on the main line between Exeter and Plymouth. In order to handle such trains on these gradients a starting tractive effort of about 60,000 lb is essential, and an adhesive weight of not less than 120 tons is required. With axle loading limited to twenty tons, six driving axles are required. The locomotive has, therefore, been designed with two bogies each having three axles, and each of the six axles is driven by an axle-mounted traction motor, geared for a maximum service speed of 90 m.p.h. The body, which is carried on the two bogies, has a full width driving cab at each end, and the power unit with the electric transmission equipment and auxiliary machinery occupies the space between the driving cabs.

The air compressor and the power transmission generator are to be driven by mechanically independent turbines, an arrangement which has an important advantage over the single shaft scheme in that any increasing load on the generator can be dealt with by simply increasing the fuel input. This action automatically speeds up the compressor and results in the establishment of correct fuel-to-air ratio and proper operating temperatures without resorting to the special provisions that are necessitated by the mechanical tie between compressor and load in the single-shaft arrangement.

The output from the power turbine will be over 2600 h.p., of which the traction generator will absorb 2500 h.p., and the remainder covers gear losses and the auxiliary generator input. The interchange of power between the compressor and its turbine works out at about 4500 h.p.

A large quantity of air is required as the working fluid of the cycle; at full load the flow is about 44,000 cubic feet per minute,



EXPERIMENTAL 1000-KW GAS TURBINE PLANT ON TEST BED

or 1·5 tons per minute. So as to reduce maintenance to a minimum, all this air will be filtered through dry fabric filters arranged in a special compartment.

The proposed lectrical transmission equipment consists of the main traction generator and the six traction motors, together with automatic control gear, which adjusts the excitation so as to utilise the full generator input power over the wide speed range of 10 m.p.h. to 75 m.p.h. The machines are proportioned to give a maximum tractive effort of 60,000 lb, and can operate continuously at tractive efforts up to 23,000 lb, corresponding to 35 m.p.h. This performance is necessary for operating the heaviest passenger trains on all the main lines, and it also enables the locomotive to handle goods trains to avoid an occasional light engine return trip.

The chief interest centres in the design of the gas turbine, which is used as the prime mover. It is of the open-cycle type, and the four parts of the heat cycle — compression, heating, expansion and cooling — proceed simultaneously and continuously. The compression, in the ratio of about 3¼ to 1, takes place in a multi-stage axial flow compressor running at 6900 r.p.m. The compressor used in the gas-turbine locomotive is very similar to that used in aircraft. The air from the compressor, already heated by the compression process, passes through the heat exchanger, where it takes up more heat from the exhaust gases. Fuel oil issuing from high pressure nozzles burns in the primary combustion chambers, which are traversed by a small proportion of the total compressed air, and the very hot gases thus produced rejoin and mix with the remainder of the air and raise it to the operating temperature before reaching the turbines.

There are two axial flow turbines mounted on separate shafts, and the hot gases flow through them in series. The first is a single-stage wheel driving the air compressor and such auxiliaries as fuel and lubricant pumps, and the second is a multi-stage power output turbine driving the electric transmission generator and the auxiliary power generator through reduction gearing reducing the speed from 4500 r.p.m. to 850 r.p.m. The discharge from the turbines passes to exhaust through the heat exchanger, where it increases the cycle efficiency by adding heat to the air flowing to the combustion chambers; this heat would otherwise have to be provided by burning more fuel.

The electrically driven auxiliary machinery comprises the air brake, compressor, vacuum brake exhauster, traction motor ventilation fans and gear oil cooler fan. They are to be supplied from 110 volt d.c. auxiliary mains, which will be fed from an auxiliary generator mounted on the traction generator shaft and driven by the power turbine. The gas turbine will be started by an electric motor fed from a battery, automatically kept charged from the auxiliary generator. An oil-fired boiler carried on the locomotive will supply steam for train heating.

The chief claims for this type of locomotive are that it concentrates high performance in small space and weight and that the gas turbine, by virtually eliminating rubbing surfaces, gives high reliability with low maintenance cost. Only an electric locomotive could give better performance within the loading gauge and axle load limit specified, and no other type of locomotive could, it is claimed, even equal it. The fuel consumption is very much lower than for a steam locomotive and, while a diesel locomotive has a still lower figure, this advantage is partly offset by the higher and more expensive grade of fuel required and by the much higher lubrication cost.

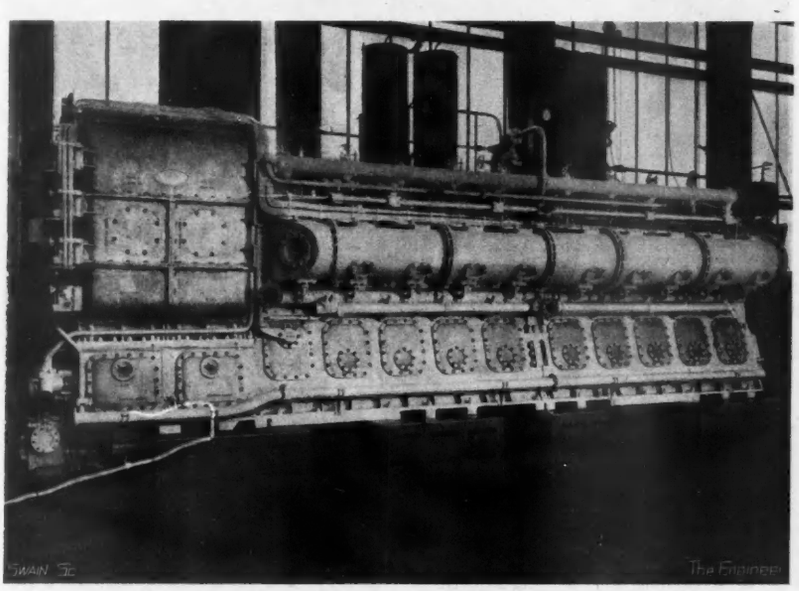
Ateliers de Construction Oerlikon, Zurich-Oerlikon, Switzerland

During the year under review we paid a visit to the Oerlikon Works, at Zürich-Oerlikon, Switzerland, and were shown the experimental gas turbine plant illustrated herewith. The turbine plant has a rated output of 1000 kW, the inlet temperature to the gas turbine being about 550 deg. Cent., or 1022 deg. Fah. Although the plant capacity is somewhat small, it embodies the layout and detailed construction which would be adopted for large gas turbine plants. The system includes inter-stage cooling between the first and second and second and third stages of the air compressor, and the gas turbine is divided into two parts, one of which drives the air compressor, and the other the generator. The arrangement of the experimental turbine on the test bed is such that all problems connected with gas turbine development can be investigated both for normal outputs and operation at partial loads. During the winter the turbine has been in permanent service under grid conditions, and it supplies current to the electrical network of Zürich. At the same time, part of the waste gases from the plant are used as combustion air in the steam boiler of the factory. An interesting part of the plant is the compressor, which embodies in its design new features of construction. The compressor rotor is of the radial type, and the casing of each stage is divided into four partial spirals to which four diffusers are connected. The transformation of velocity into pressure takes place under favourable conditions in the straight diffusers, giving a high efficiency. Another interesting part of the three-stage radial compressor construction which is shown in our engraving is the arrangement of the intercoolers. They are arranged around the casing of the air compressor at equal angles of 90 deg. and one of the four parallel parts of the intercoolers can be seen to the extreme right of the view we reproduce. Each of the four intercoolers is in two halves, one of which is connected between the first and second stages of compression and the other between the second and third stage of compression. The compressor is designed to work at a pressure of four atmospheres or about 42·7 lb per square inch gauge. The two gas turbines, with their interconnecting pipes, will be seen in the centre of the picture and the generating unit to the left. We shall continue the description of this plant in our next article.

(To be continued)

Submarine Engines for the Turkish Navy

AN interesting contract during the late years of the war, was that for two large submarine oil engines of Sulzer design for the Turkish Navy, particulars of which are now released. The engines were built by Sulzer Brothers (London), Ltd., at the old Hathorn Davey Works, Sun Foundry, Dewsbury Road, Leeds, and were the first oil engines to be built at its works.



Side View of Engine on Exhaust Side

The engines are directly reversible and they have an increased output per cylinder compared with older non-reversible Sulzer submarine engines built under licence in England. They are ten-cylinder units, compared with the six cylinders used in all earlier engines, and thus form a new model, not yet built by the parent company in Winterthur. They were constructed in accordance with Admiralty standards, and they also fulfil certain requirements suited to operation in Near Eastern waters.

They are of the single-acting trunk-piston, loop-scavenge type, and the principal dimensions and particulars of the sets are as follows :—

Diameter of cylinder	350 mm
Piston stroke...	450 mm
Rated output for continuous service ...	2,400 b.h.p.
Running speed	500 r.p.m.
Rating for 36-hour endurance trial ...	1920 b.h.p.

It may be recorded that the endurance trial rating is only about 80 per cent of the

Admiralty figure, and from 76 to 77 per cent of the maker's normal 2500 b.h.p. rating, but it is a conservative value suited to Turkish stipulations.

The general appearance of the engine will be seen from the accompanying engraving, Fig. A, which shows a view of the engine taken on the exhaust manifold side. The bedplate is of cast steel, and it is made in three sections, one of which is below the scavenge pump. The sump is of fabricated

PISTON AND CONNECTING ROD

steel plate, which is welded to the bedplate casting. The cast iron cylinders are arranged in two groups of five and are bolted to the crankcase. The construction of the main bearings follows on lines introduced by Sulzer Brothers some years before the war. All main bearings have cast steel shells with white metal linings, and are keyed into the frame along the top machined surface. Further, a toothed locking arrangement is fitted to the tapered keys enabling exact bearing adjustment to be made.

In accordance with standard Sulzer practice, an alloy steel is not used for the crankshaft, but a carefully treated carbon steel of 32 tons to 38 tons per square inch ultimate tensile strength. A similar steel is used for the I-section connecting-rods. Neither the journals nor the crankpins are hollow bored. Much attention was devoted to the incorporation of the best modern practice, which included the recessing into the webs of the end radii of the pins and shaft. The big end bolts also come in for special consideration, not only as regards material but also detailed design. Both the bolts and the nuts are securely locked, and the nuts have a deep spigot bearing on the rod foot, while the bolts have a maximum stretching length, with a diameter less than the root diameter of the thread. A four-bolt layout is used for both the big end and the small end of the connecting-rod. The gudgeon pin is so designed that it can be ground circular as a whole and the flats ground at a subsequent stage, while a maximum area to take the downward thrust is provided.

The piston, illustrated herewith, has a cast iron skirt, and a forged steel head. The cylinder liner is made in two parts, the top portion forming a dry liner in the cylinder head. Should the piston rings call for inspection or renewal, the head with the top portion of the liner is lifted off, and the engine then barred round until the five pressure rings come in sequence above the top of the main portion of the liner. The piston rings can then be handled without having to disconnect the piston from the rod or dismantling the big end. This feature, besides providing easy access, results in a reduction in the necessary overhauling height.

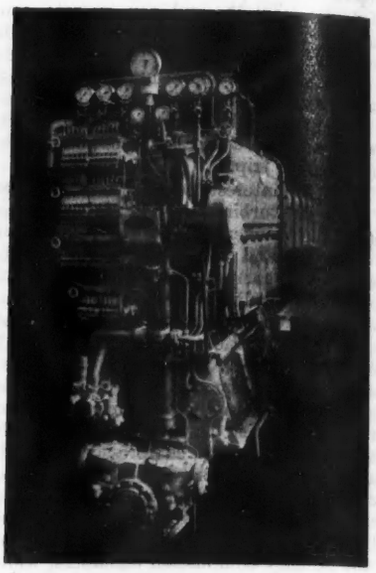
The pistons are oil-cooled and the pressure and circulation of the piston cooling oil is maintained by a Drysdale pump, which is driven from the scavenge pump shaft. This pump also provides the lubricating oil for the engine. Telescopic tubes are used to convey the oil to and from the piston head, and hand adjustment of the flow to each piston is provided for. There is a Serck cooler separate from the engine, with a by-pass for regulating the oil temperature.

The fuel-injection system is of Sulzer design, but the component parts were manufactured by Simms Motor Units, Ltd., to Sulzer requirements except for certain nozzles supplied by Bryce Fuel Injection, Ltd. The fuel-injection nozzles are of the multi-hole type, centrally disposed, and they are cooled by a separate fresh-water system maintained by a Drysdale gear-driven pump.

The camshaft is driven by spur gearing at the aft end of the engine. It operates the five fuel-injection pump units, and also drives a short horizontal shaft with a sliding cam for the air starting pilot valves. It also drives a vertical shaft for the governor, mounted at the aft end of the engine, which is connected to the fuel pump control shaft through a simple and direct mechanical linkage. For normal running conditions, the governor is set as an overspeed device, which prevents racing of the engine in bad weather. For battery charging, however, the engine is set by the governor for a definite speed.

VIEW OF CYLINDER TOPS

The pipes from the fuel pumps to the injection nozzles have been specially lengthened in order to give correct timing of injection into the cylinders for both forward and reverse running, as only one fixed cam is used for each injection pump unit for both directions of running. An Auto-Klean filter is inserted in the fuel system between the service tank and the injection pumps. Sea water cooling is used for the engine jackets and circulation is maintained by two Drysdale pumps driven by Laurence Scott electric motors having Allen



END VIEW SHOWING CONTROLS

West controllers. The accompanying engraving shows the tops of the cylinders. Each cylinder outlet branch is fitted with a valve which permits of individual adjustment of the water flow to give equal outlet temperatures from every cylinder. This feature of individual control and measurement is found also in the piston-cooling water circuit, the injector-cooling system, and in the main exhaust.

The engine is started by compressed air, which is admitted to five cylinders through valves in the cylinder heads, controlled by pilot valves alongside the fuel pump units. The engine is reversed by moving a short camshaft under the pilot valves, the position of the main camshaft being unchanged. The necessary starting air is furnished by a separate air compressor set, and is stored in bottles at a pressure of about 2000 lb per square inch; it is supplied to the five cylinders through a reducing valve set at a pressure of about 600 lb per square inch.

The scavenging of the engine is effected by reciprocating pump mounted on an extension of the main crankshaft. It is of the twin-throw tandem type and has four cylinders, with a bore of 640 mm and a stroke of 280 mm. The scavenge pump inlet and discharge valves are of Sulzer standard spring-strip design, and they are arranged in four groups for each connected pair of scavenge cylinders. On the suction side of the pump an induction silencer is fitted, with each induction passage formed in the shape of a venturi nozzle, an arrangement which effectively reduces the noise made by the scavenge pump.

Several detailed improvements have been made in the construction of the scavenge pump compared with the equipment used on T-class submarine engines, with the objects of gaining longer service operation and greater simplicity.

The engine-driven pumps for the piston cooling, lubricating oil, and fuel valve water cooling, have automatic valves enabling the engine to be reversed without changing the direction of pumping.

Our final illustration shows an end view of the engine, the arrangement of the controls,

tachometer and pressure gauges, &c. From the forward end of the scavenge pump crankshaft there is also a vertical skew drive to the manœuvring gear, and drives therefrom are taken to the cylinder lubricators, tachometer, counter and the interlocking gear for the fuel control. The lubricator operating gear is interconnected with the fuel lever, so that the amount of lubricant supplied to the upper portions of the cylinder liners is regulated automatically according to the amount of fuel being injected.

Throughout their continuous running tests, these two submarine engines classified by Sulzer as the 10QD38 type, showed excellent characteristics. In the cruising speed test the engines developed 1920 b.h.p. when running at a speed of 465 to 470 r.p.m., the average fuel consumption of pool gas oil being 0·411 lb per b.h.p. hour, while the corresponding exhaust temperature was below 285 deg. Cent. If anything, the noise and vibration, we are informed, were less than usually observed with large submarine oil engines.

The Development of an Axial Flow Gas Turbine for Jet Propulsion*

By D. M. SMITH, D.Sc., M.I. Mech. E.†

Preliminary Work on Gas Turbines for Aircraft Propulsion

Discussions on the practicability of gas turbines for aircraft propulsion took place between Metropolitan-Vickers and the Royal Aircraft Establishment, Farnborough, in 1937, and in the following year the company started gas turbine development work under an Air Ministry contract. The Metropolitan-Vickers staff concerned with this development were steam turbine engineers, and it was natural that they should have considered gas turbine possibilities from time to time. It was evident that gas turbine plant normally showed to advantage only with much higher operating temperatures than were in use in steam turbines, and that the materials then available did not permit these much higher temperatures for long service such as would be required for power station plant. Creep phenomena, however, permit of much higher temperatures being carried for a short time, and high temperatures would therefore be admissible in short-life plant, such as engines for military aircraft. Thus it came about that the initial applications of gas turbines in this country were to aero-engines—a field of engineering which in some respects presents peculiarly difficult problems.

The early work was carried on in collaboration with the Royal Aircraft Establishment. Some account of the R.A.E. contribution has already been given by Constant (1945).

The gas turbines with which this paper is concerned have all operated on the simple cycle of compression, continuous combustion, expansion through a turbine, and discharge through an exhaust nozzle. The compressors used throughout have been of axial flow type. It was realised that the development problems, presented by multi-stage axial flow compressors, were greater than for single-stage centrifugal compressors, but it was decided that the ultimate capabilities of the former were far beyond those of the latter.

The engines at first considered were power turbines intended primarily to drive propellers, but producing also some thrust from the exhaust velocity. It was known that a pressure ratio not less than 5/1 would be necessary to obtain reasonable fuel consumption, and that difficulties due to inflexibility of characteristics might arise on an axial flow compressor for high pressure ratio. It was therefore decided to work with compound compression in two stages with independent drive for each of the compressors. Several projects laid out at this time had three turbines in series, one driving each compressor while the third drove the propeller. The compressors were not co-axial, and volutes and cross-over ducts were required between the various lines of compressors and turbines. In view of the elaborate nature of this plant, and of the number of unknowns, it was decided that a complete engine should not be built immediately, but that an experimental plant should be constructed, consisting of a simple arrangement of components of an engine of this type.

This plant was known as the B10, and it included in series a nine-stage axial flow compressor, a combustion chamber, and a four-stage turbine. Starting was effected by electric motor, and there was no delivery of external power, but the plant could be loaded by blowing off air from the compressor outlet. The main components were rig-tested as built—the compressor by steam turbine drive; the combustion chamber by air supplied from the compressor so driven, and the turbine on superheated steam with power delivered to a dynamometer. In October, 1940, the whole plant was assembled and run as a gas turbine. The performance was generally successful, and the running was most impressive with the turbine at a bright red heat at the high-pressure end and a dull red heat at the low-pressure end. The experience obtained in designing, manufacturing, rig testing, and engine testing was of the utmost value for all subsequent gas turbine work.

Before the B10 plant had run, the practicability of the compound cross-over type of engine was in question. The projected engines were found to be heavy and bulky, and air flow tests made on the inlet and outlet volutes indicated serious pressure losses, which led to the consideration of straight-through engines with their components arranged in line. Compound-compressor arrangements of this type were set out and were seen to present mechanical difficulties, but it was thought practicable to build an engine with a single compressor giving a full-speed pressure ratio not less than 5/1.

It was decided in 1939 to build the D11 engine on these principles. The engine includes a seventeen-stage axial flow compressor, an annular combustion chamber, a high-pressure turbine driving the compressor, and a low-pressure power turbine—all arranged on a common axis. The engine, which had a designed output of 2000 h.p., was intended to investigate aerodynamic and thermodynamic possibilities for aircraft propulsion, but was not a flight prototype.

All the components of the engine were built, and the compressor and combustion chamber were rig tested, but the compressor, being designed before the B10 compressor had been tested, was found on test to be aerodynamically too ambitious. The pressure ratio of 5/1 was not attained at designed speed and the stalling characteristics were unsuitable. Minor modifications were tried, but they failed to improve the characteristics sufficiently. The compressor could have been rendered suitable by rebuilding with blading redesigned in the light of later knowledge, but in 1941 facilities were not available for this, owing to the higher priority accorded to the F2 simple jet propulsion engine. The D11 engine was therefore never assembled.

Description of the F 2/4 Engine

As an introduction to the development history of the jet propulsion engine, a short description is given of a recent engine, the F 2/4, in its initial build. A sectional arrangement of this engine‡ is given in Fig. 1 and the rotor is shown in Fig. 2.

Air enters the engine, as represented in the sectional arrangement, from the left, and in flight this entry air is raised in total head by the ram effect of the flight velocity. It is compressed in the ten-stage axial flow compressor, which includes a row of preliminary guide vanes followed by ten alternate rows of moving and fixed blades—the moving blades being carried on a light alloy drum, and the fixed blades on a casing of light alloy castings.

The compressed air passes through a specially shaped diffuser to a combustion chamber, which is a complete annulus. The greater part of the space is occupied by an internal annular chamber—the primary chamber—within which combustion takes place. Fuel is injected through twenty fuel jets which spray upstream against the backplate of the primary chamber. A certain quantity of air—the primary air—is introduced through holes in the backplate, and the greater part of the combustion takes place in the upstream end of the chamber. The remainder of the air—the secondary, entering the primary chamber through wedge inlets and holes in the inner and outer walls—serves largely to dilute the products of combustion to a temperature suitable for the turbine blading.

The products of combustion expand through a single-stage turbine which drives the compressor, but owing to the high temperature of the gases, the pressure drop necessary to drive the turbine is much less than the pressure rise in the compressor. The exhaust gases pass through the conical exhaust and expand finally through the propelling nozzle, leaving it with high velocity. A parallel tail pipe can be inserted between the exhaust and the propelling nozzle when installation conditions require it. The static pressure at exhaust from the propelling nozzle is approximately equal to the static pressure of the surrounding atmosphere,

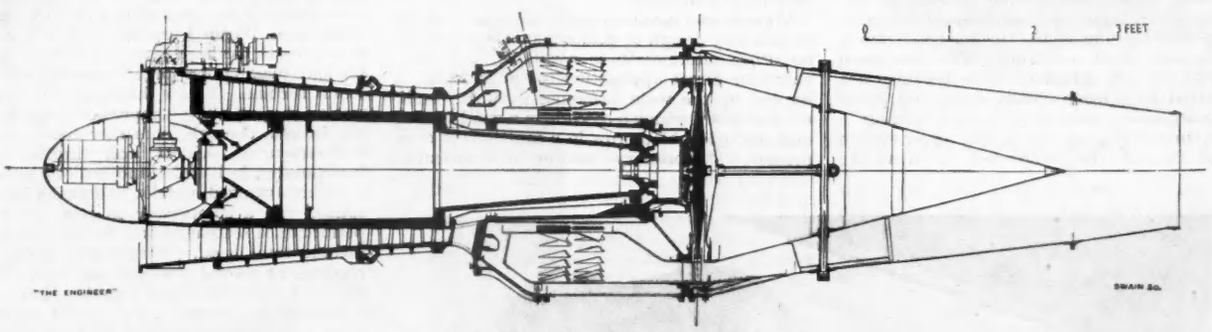


FIG. 1—*A Sectional Arrangement of the F2/4 Engine*

* Institution of Mechanical Engineers, January 10th. Abstract.

† Chief Engineer, Gas Turbine Engineering Department, Metropolitan-Vickers Electrical Company, Ltd.

‡ This engine was illustrated on page 43 of our January 10th issue ED. THE E.

and consequently the engine transmits to its supports a resultant thrust which corresponds approximately to the rate of change of momentum between the undisturbed air and the propelling nozzle exhaust.

The engine is carried through two main mounting brackets on the compressor outlet branch, and two steady brackets near the forward end of the compressor casing. The main structure downstream from the compressor outlet branch consists of a casting inside the combustion chamber which carries the turbine bearing housing, and a conical diaphragm which carries the turbine fixed blades. The exhaust

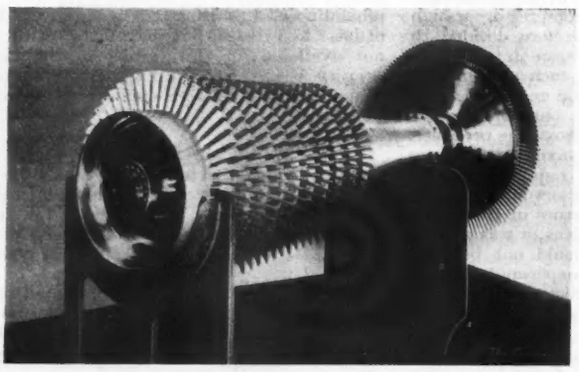


FIG. 2—*Rotor of F2/4 Engine*

is located axially by the combustion chamber casing, but is centred by splined guides on the outside diameter of the turbine fixed blades.

The rotor is carried on two ball bearings—a combined thrust and journal bearing at the compressor end, and a journal bearing, mounted in a splined housing, at the turbine end, leaving the turbine wheel overhung. The two main bearings and the auxiliary drive bearings are lubricated by a mechanically driven oil pump with a separate positive feed to each bearing.

The turbine bearing is cooled by an air stream tapped through the compressor drum at the fourth stage, which air passes inside the drum and conical extension and flows to and round the turbine bearing by a series of cooling air passages. The air leaving the bearing is laden with oil mist, and is ultimately vented through hollow ribs in the compressor outlet branch, and is exhausted through ducts to atmosphere. Other streams of cooling air are taken from the compressor outlet to each side of the turbine disc.

An electric starting motor is mounted in the compressor nose. A drive from the main rotor comes to a group of engine auxiliaries maintained on a gearbox outside the compressor inlet casting, and a coupling is provided for drive to an aircraft auxiliaries gear box. The components of the fuel control system are mounted on the outside of the compressor casing.

The engine is started by the starting motor, and fuel is ignited by duplicate sparking plugs to each of which a jet of priming oil is fed at starting. The sole control of the engine running conditions is provided by regulation of the fuel supply. When this or the flight condition is altered, the engine speed, through-put, and thrust quickly settle down to a new equilibrium running condition. A later version of the F 2/4 engine has the starting motor mounted outside the compressor casing, and the electric starter is interchangeable with a petrol starter.

Development of the Engine Components

Each main component of the engine necessitated development work in a field previously unexplored, and only an outline can be given.

Axial Flow Compressor.— Aerodynamic design of the blading for the earliest axial flow compressors was based on wind tunnel tests of blade cascades carried out at the R.A.E. Later, Metropolitan-Vickers built low-speed and high-speed wind tunnels of their own, and have used them extensively for compressor blading and other work. These wind tunnels include some remarkable features, of which an account will shortly be published.

Wind tunnel cascade results are useful for the preliminary design of compressor blading when no other information is available, but their value for direct application to this purpose is limited by the wide difference between conditions of flow through a cascade in a wind tunnel, and through a blade row in a multi-stage compressor. The primary function of wind tunnel research in relation to axial-flow compressor design has therefore changed with time. At first the wind tunnel results were used in absolute value for direct application to design of compressor blading; later wind tunnel tests were used relatively for comparison between different blading and different flow conditions. The tendency is now for tunnel testing to be used in conjunction with theoretical analysis for better understanding of the physical nature of flow through blading. Concurrently with these changes there have been great advances in the technique of testing cascades in wind tunnels.

Analytical investigation has provided a powerful tool in advancing the science of blading design when used in conjunction with testing. Some of the early work in this field has been given by Merchant (1890 and 1893). Ordinary aerofoil theory, based on wind tunnel tests on isolated aerofoils, has been found of little value for the closely pitched blading of the F2 compressor.

The most important contribution to compressor development has been that provided by the testing and test analysis of complete axial compressors. During the development

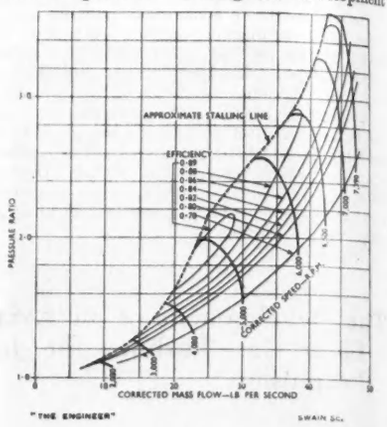


FIG. 4—*Conventional Test Characteristics of First F2 Compressor*

of the F2 engine, fourteen different compressors have been tested, some of them in more than one build.

Earlier compressors were tested by driving by steam turbine in the works steam turbine testing department. For the F2/4 compressor, these facilities were inadequate, and by arrangement with Wigan Corporation a compressor-testing berth has been equipped at Wigan power station, making use of an existing 6000-kW steam turbine. Fig. 3 shows a compressor on test on this rig. The compressor is driven from the turbine through increasing gears, and has flow-measuring orifices and throttle valves incorporated in its inlet and outlet ducts, with silencers arranged at inlet and outlet to atmosphere. In a compressor on test, the overall performance readings taken for each test point include total head, pressure and temperature readings at several points on the inlet and outlet, and also rotational speed. Provision is also made for stage-by-stage tappings, and for total head traversing, and these readings are taken in tests which are to be the subject of detailed analysis.

Most compressor testing has been carried out with throttled inlet, as this saves power and relieves the load on the thrust bearing. Sufficient testing has been carried out with throttled outlet to verify the approximate accuracy of the similarity rules used for correction of observed results to inlet conditions at normal temperature and pressure.

The compressor characteristics normally plotted from tests are conventional characteristics which are convenient to measure experimentally, and which have a comparative significance with somewhat similar compressors tested in the same way, but which do not represent true absolute values of pressure rise and efficiency. These conventional characteristics are based on the total head and temperature readings at a limited number of points at mean diameter of compressor inlet and of compressor outlet. The conventional characteristics so obtained on the first F2 compressor are shown in **Fig. 4**, in which the approximate stalling line is indicated.

(To be continued)

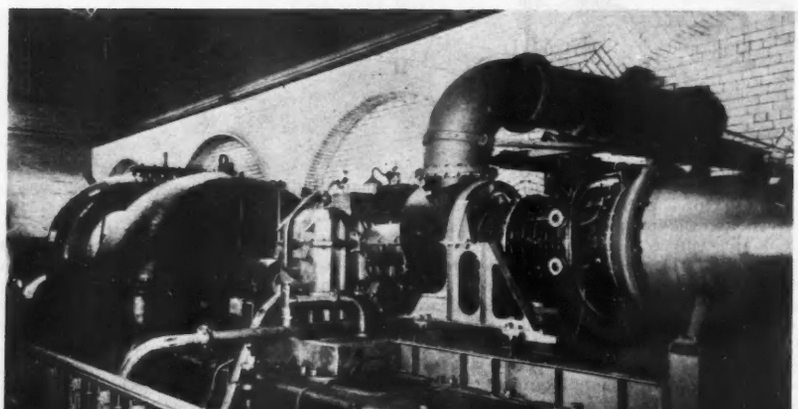
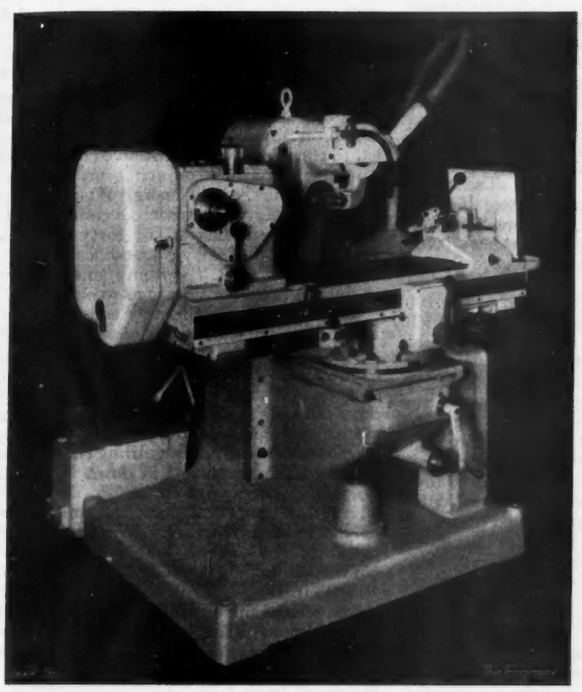


FIG. 3—*Compressor Test Rig*

The Welsh Industries Fair.—Attendances at the Welsh Industries Fair, held in London from January 1st to 7th, exceeded 39,000. It is stated that buyers came from five continents and that total home and overseas orders placed are estimated at £5,000,000.

An Automatic Hob and Helical Spline Grinding Machine

It is not generally known that a fairly large proportion of the capacity of the Shrewsbury works of the old-established firm of security engineers, the Chatwood Safe and Engineering Company, Ltd., is devoted to the production of a variety of special purpose plant for the food and other industries. In the course of a recent visit to these works we were able to see the latest of the firm's products—a new grinding machine for sharpening straight or helical gashed gear hobs and form relieved cutters, in which the lead, the indexing and the feed are fully automatic. The machine is also designed for grinding straight or helical splines by means of formed wheels, and attachments are available to enable the grinding of the involute tooth forms on Fellows type gear cutters. We were informed by the company that production of the new machine was begun some eighteen months ago when it was found that no fully automatic British made machine of this type was available to industry.



HOB AND SPLINE GRINDING MACHINE

In its standard form, the machine is fitted with a disc grinding wheel, the spindle of which is driven at 2830 r.p.m. by a 2 h.p. electric motor within the enclosed headstock. If desired, the machine can be fitted with dual spindles, as shown in the accompanying engraving. In this arrangement the upper spindle carries a standard disc wheel and the lower spindle a pencil wheel. The lower spindle is belt-driven at a speed of 10,000 r.p.m. from the headstock motor through an adjustable idler pulley. Both spindles are mounted in pre-loaded ball journal bearings, having provision for thrust.

When grinding gashes in hobs the disc wheel has the cutting side to the rear, and in its vertical plane at line of contact with the face of the workpiece. The pencil wheel is used to grind hobs which combine high angle and deep gash, and cause interference when using a disc wheel. Hobs up to 6in diameter can be ground with the pencil wheel, and for larger sizes a high angle dressing unit for use on the disc wheel can be used. This unit is mounted between the work centres and imparts a correctly curved profile on the wheel by generation. Wheels so dressed grind true radial faces on hobs having high angle gash spirals. Both types of wheel will grind a true radial face on the teeth of either straight or helical gashed hobs and on form relieved cutters.

The table is arranged to swivel on the knee 45 deg. in either direction in order that the work may be set at an angle when helical grinding is being done. It carries the work head spindle rotating the indexing and the feed mechanisms. Automatic longitudinal traverse to the table is through a leadscrew. Backlash adjustment incorporated in the table leadscrew nut compensates for any backlash in the headstock, and enables grinding to be carried out in both forward and reverse strokes of the table. Adjustable stops are provided to control the length of table traverse. A centrally disposed control handle which engages the traverse clutch gives continuous rapid control of all table movements. Table cross traverse and vertical adjustment for height can be effected through handwheels provided with index dials for fine-setting purposes.

The workhead spindle is carried at its nose end in a taper roller bearing, which is pre-loaded by a clutch spring, and at the rear end by bronze bushes. It is driven through a friction clutch which is designed to ensure steady grinding conditions and damp out any possible chatter from the gear train.

The spindle rotating and indexing mechanism is carried in an enclosed head, having a large door giving easy access to the pick-off gears and indexing discs. In it the self-acting longitudinal traverse of the table is coupled by change wheels through worm gearing to the spindle. Change wheels can b selected and set to produce the required rotation of the work spindle during the table stroke for the grinding of helical angles on hobs or cutters. A clamping screw is used to stop the rotation of the spindle when straight cutters are being ground.

Indexing of the spindle is effected through removable index discs by the use of which the work is automatically indexed, one step at the completion of each grinding stroke. A certain number of standard indexing discs are supplied with the machine, and provision is made for fitting them with masking plates to increase the range of work for the minimum number of master discs.

The feed mechanism within the head provides automatic radial feed after each complete revolution of the work. It can be set by means of a large graduated drum at the top of the head to feed in increments of 0·0006in or multiple increments from 0·0006in to 0·003in. This automatic feed can be arranged to cut out after a predetermined number of feed increments have taken place. The feed is radial and figures for feed have been computed on 5in diameter work and they alter proportionately on larger or smaller diameters of work.

The wheel spindle and table drive motors are controlled by a single push button at the top of a pedestal bracket mounted at one side of the machine base.

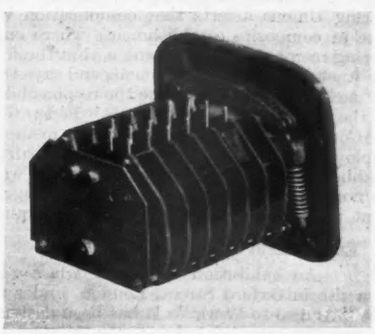
Dust exhausting hoods, fitted to both grinding wheels, are suitable for connecting up to either an individual separator or a central exhausting system. As wet grinding is necessary for certain classes of work, the machine tables, &c., are supplied to a standard suitable for wet grinding.

For the grinding of Fellows gear cutters a special dressing attachment for the disc type wheel is available. With this dressing attachment movement of the diamond forming the wheel is controlled through former plates having a magnification ratio of six to one. By the use of suitable former plates this attachment can also be used to form-grind splines or flutes having a radius between the keys or flutes and the shaft diameter. To form the wheel for normal square corner spline grinding a three-diamond attachment is mounted on the machine table.

Cam-Operated Control Switch

A MODIFIED version of the well-known dual-handle, cam-operated, combined reversing and four-speed selector switch (type 754) is now being manufactured by Brookhirst Switchgear, Ltd., of Chester. The new switch, which is available in various forms for reversing duty only, is particularly suitable for controlling machine tools.

Two ratings are in production, designed for frequent reversing and reverse-current braking duties: a three-pole switch rated at 3½ h.p. and a six-pole switch rated at 7 h.p., both of which are suitable for working voltages up to 550 volts. Alternative forms are available with single-handle operation for two positions (forward-reverse) or for three positions (forward-off-reverse).



CONTROL SWITCH

As illustrated herewith, the flush-mounting switch is of compact design with a small cavity space and readily accessible terminals. The heavy butt contacts have a rolling action and are easily replaceable. Arc chutes and separators are provided between the poles.

BRITISH COMMONWEALTH SCIENTIFIC CONFERENCE.—The establishment of a British Commonwealth Scientific Office in London is one of the main recommendations to Governments made in the Report of Proceedings of the British Commonwealth Scientific Official Conference, recently published by H.M. Stationery Office, price 1s. 3d. The Official Scientific Conference, it may be recalled, followed on the Royal Society's Empire Scientific Conference last July. Its primary concern was to discuss scientific collaboration, which had grown up in the Commonwealth during the war, and to devise means of ensuring its continuance and improvement. Consequently most of the resolutions are of an administrative or organisational aspect rather than of direct scientific interest. A large number of resolutions was passed by the Conference and will be considered by the Governments of the United Kingdom, the Dominions and India. Experts in every field from every country represented could not be present to enable authoritative views to be put forward on every subject. Therefore in most instances the report recommends that specialist discussions or conferences should be held at a later date. Broadly, the proposal to set up a British Commonwealth Scientific Office in London is that the various Dominion Scientific Missions and Liaison Officers in London should occupy adjoining offices in the same building, so that while retaining full autonomy and responsibility to their Governments, they would be able to co-operate more easily in matters of common interest.

Industrial and Labour Notes

Shipyard Hours

Following a meeting of its Executive Council, on Thursday of last week, the Confederation of Shipbuilding and Engineering Unions issued a statement expressing its complete and profound dissatisfaction that the Shipbuilding Employers' Federation had been unable to agree to a five-day week for the shipbuilding industry.

Originally, the unions put forward a claim for a reduction from forty-seven hours to forty without loss of pay, and a five-day week, and at one stage of the negotiations it seemed likely that agreement to a forty-four-hour week would be reached. The employers recommended that these hours should be spread over five and a half days, but the unions were insistent upon a five-day week. The failure to reach agreement was reported to the Minister of Labour, who decided that the matter should be considered by a court of inquiry. Sir John Forster, K.C., is presiding over this court of inquiry, the other members of which are Sir Frederick Rees and Professor I. W. MacDonald.

The Confederation of Shipbuilding and Engineering Unions asserts that complication will arise in composite establishments where engineering members already come within the five-day week engineering agreement, and says that any such complication will be the responsibility of the Shipbuilding Employers' Federation. The Confederation has instructed all its members employed in shipbuilding and ship repairing establishments to continue to observe and work the normal hours in accordance with the agreement, pending the report of the court of inquiry.

Employment of the Disabled

An exhibition was opened last week on a site in Oxford Street, London, under the title "And so to Work." It has been designed by the Ministry of Labour, the Ministry of Health and the Ministry of Pensions, and its purpose is to demonstrate the skilled and other useful work which can be successfully carried out under industrial conditions by disabled persons.

At the exhibition, disabled men and women may be seen engaged in the assembly of various engineering products, draughtsmanship, the manufacture and assembly of artificial limbs, watch and clock repairs, diamond polishing, wrought iron work, typewriter repairs, furniture making, telephony, and other occupations.

The exhibition gives a good impression of the work which is being done at industrial rehabilitation centres in various parts of the country, the aim of these centres being to help disabled men and women to get back to work after injury or illness. Arrangements are also made for training disabled people in certain trades, such training being given at Government training centres, technical colleges and, in some cases, in employers' works. It is of interest to note that by the end of 1946 over 700,000 people had been registered under the Disabled Persons (Employment) Act.

Manpower

An address surveying the industrial manpower situation of this country was delivered by Sir Godfrey Ince, Permanent Secretary to the Ministry of Labour, at a meeting of the Institute of the Motor Industry on Thursday of last week. Talking about the future, Sir Godfrey said that he was not in a position to disclose the 1947 manpower budget, but he could say that the year was going to be a period of acute shortage of labour.

Taken as a whole, the country's manpower had been running down since 1943, and it would continue to run down during the present year. In 1939, Sir Godfrey explained, there were 417,000 young men reaching the age of eighteen; in 1946 the number was 335,000 and in 1950 it would be 295,000. Furthermore, with the raising of the school-leaving age, industry in ten years' time would have only one-half the juveniles it possessed to-day. Industry must therefore look forward to a shortage of manpower for some considerable time to come.

Sir Godfrey pointed out that the mere transfer of labour from some industries into others which were particularly short would not solve the problem. With a country short of manpower there was only one thing that could be done to help the economy of the nation, and that was increased production, which was a joint responsibility of management and labour.

Trade Disputes

The official figures relating to trade disputes leading to stoppages of work in November show that there was an appreciable decline in the number of people involved and the number of working days lost compared with the month of October.

There were 176 disputes involving stoppages of work reported to the Ministry of Labour as beginning in November, and, in addition, there were twenty-two stoppages which began before November, but were still in progress in the early part of that month. In these 198 stoppages there were 44,000 workers involved in November, which figure includes those thrown out of work by the stoppages at the establishments where the disputes occurred. The aggregate number of working days lost was 131,000. In the month of October there were 238 stoppages in progress, involving altogether 70,700 workers and resulting in an aggregate loss of 289,000 working days.

Statistics relating to the duration of the 190 stoppages of work through disputes which ended in November show that 78 lasted not more than one day, 41 lasted two days, 21 lasted three days, 33 lasted four to six days, and 17 lasted for more than six days. Of the disputes leading to stoppages of work which began in November, 25 arose out of demands for wage increases and 61 related to other wage questions; 2 were concerned with working hours; 19 involved the employment of particular classes or persons; 58 related to other questions over working arrangements; 8 were concerned with matters of trade union principle; while 3 of the stoppages were in support of workers involved in other disputes.

Coal Output

Statistics regarding the output and consumption of coal in Great Britain during the month of November, together with preliminary figures for December and for the year 1946, were issued on Wednesday last by the Ministry of Fuel and Power. They show that in the four-week period ended November 23, 1946, the weekly average saleable output of mined coal was 3,734,900 tons, compared with a weekly average of 3,687,000 tons in October. With regard to the month of December, output of mined coal in the week ended December 14th was 3,908,700 tons, and the Ministry observes that, during the period of the Christmas and New Year holiday, output was 1,000,000 tons higher than in the corresponding period of 1945. The output of open-cast coal averaged 161,000 tons a week in November, a decline compared with the October figure and attributable to heavy rain.

The total tonnage of mined coal lost in November averaged 66,200 tons a week, of which 15,500 tons were lost through disputes, 34,400 tons through accidents, breakdowns and repairs to machinery, 10,800 tons through rail transport difficulties and 5500 tons through other causes. The average number of wage-earners on colliery books in November was 691,500, of whom 640,600 were effectively employed. Voluntary absenteeism amongst coal face workers was 10·35 per cent, and the average output per manshift worked at the face was 2·82 tons.

The total inland consumption of coal in November averaged 3,809,000 tons a week, but this figure was added to considerably during the three weeks preceding Christmas owing chiefly to higher consumption at electricity and gasworks. The Ministry of Fuel and Power estimates that the coal consumption at electricity works in Christmas week was approximately 33 per cent above that for 1945.

The provisional figures for the whole of 1946 indicate that the output of saleable deep-mined coal was 180,500,000 tons, compared with 174,657,900 tons in 1945, and that the output of open-cast coal was 8,800,000 tons, compared with 8,114,800 tons in 1945. The inland consumption of coal in 1946 is estimated as being 184,600,000 tons, compared with 178,600,500 tons in 1945, whilst exports and foreign bunkers accounted for 8,750,000 tons, compared with 8,200,000 tons in 1945. The average weekly number of wage-earners on colliery books in 1946 was 696,700, compared with 706,400 in 1945, and the output per manshift overall was 1·03 tons, compared with 1·00 ton in 1945.

Road Haulage Workers' Strike

An unofficial strike, involving several thousand road haulage workers in London, began on Monday, January 6th, and has since led to considerable dislocation of food and other supplies. The men on strike are members of the Transport and General Workers' Union, which, last May, put forward a claim for a forty-four-hour week instead of forty-eight hours, without loss of pay; modification of the "cumulative week" system; and an increase in annual holidays from one week to two.

This claim was ultimately considered by the Road Haulage Central Wages Board, but its proposals were not made known until December 31st. The Board did not accept the claim for a shorter working week, it recommended nine days' holiday instead of twelve, in addition to statutory holidays, and did not agree to most of the concessions sought regarding the cumulative week. The procedure laid down by the Road Haulage Wages Act provides that, in the twenty-one days following the announcement of the Central Wages Board's findings, objections can be lodged, and the proposals are considered by the area boards. The Central Board then decides whether to submit its recommendations to the Minister of Labour for confirmation. The strike was staged as a protest against the Central Board's recommendations and was contrary to the wishes of the union concerned.

Towards the end of last week the Government announced that members of H.M. Forces would be employed to move foodstuffs necessary to the well-being of the community, and it was also stated that the Minister of Labour would not confirm any award which the Central Wages Board might make until the men returned to work.

An emergency meeting of the Road Haulage Central Wages Board was held on Monday last, but, after legal advice had been taken, it was concluded that the Board could legally make no effective decision until the twenty-one-day period for the lodging of objections had elapsed. Further consultation between employers and union representatives and Ministry of Labour officials led to the constitution on Tuesday last of a National Joint Industrial Council for the road haulage industry. This Council consists of twenty members—ten from each side of the industry—and provides machinery for the speedy settlement of any differences that arise. Two secretaries, representing the employers and the workers, have been appointed and arrangements were made on Tuesday for a meeting of this Council to be called immediately the strikers returned to work.

Meanwhile there was some extension of the strike to places in the provinces and to some other grades of workers in markets and docks. As we go to press, however, there are expectations that the men will decide to return to work, thereby enabling the Joint Industrial Council to consider the union's claim.

French Engineering News

(From our French Correspondent)

PARIS, January 10th.

The nationalised Pas de Calais Mines have published their development and modernisation programme. This includes the introduction of a concentrated transport system in the mines which will follow the important galleries and comprise 60 h.p. electric locomotives running on batteries; the adoption of compressed air turbine type engines to drive automatic picks. Special type motors will be used in some mines, however, because of danger from coal damp.

Present 200, 400 and 600 h.p. air compressors will be replaced by 900 and 1800 h.p. compressors. Pumps, ventilators and lifts will all be electrically controlled. Various American methods will also be used which will enable the closing of uneconomic galleries and pits while intensifying production in other galleries and pits. It appears that there was some controversy between engineers on the relative merits of compressed air and electricity. The present solution of using both is considered as satisfactory.

Out of the 125 milliard francs earmarked for the modernisation of the mines in the Monnet Plan, the Nord and Pas de Calais will receive 50 milliards.

* * *

Production of iron ore continues to be below 1,300,000 tons in spite of a peak of 1,373,966 tons last May. This largely corresponds to supplies needed for French metallurgical plants and exports, as it is not desired to increase stocks excessively. Increased coal imports during the summer enabled a further 9 blast-furnaces to be lit after June, and production of iron passed from 264,000 tons in June, to 304,000 tons in July, with steel increasing from 343,000 to 377,000 tons in the same period. Monthly production of electro-steel which was 32,000 tons in 1938, was 13,000 tons in May, 1945, and rose to 40,000 tons in June, 1946.

* * *

Schneider and Company have inaugurated the first of the new workers' cities at Creusot, which are to re-house homeless personnel. The construction comprises 215 dwellings, with all modern comforts, and a second is expected to be finished in 1948. During the inaugural ceremony tribute was paid to the recovery of pre-war production capacity of the works. It was stated that production which was now largely supplying civilian needs, was far superior to that of 1938.

* * *

Electricity undertakings in France are very satisfied with their performance during the recent cold spell. Record output for the coldest day was 80,800,000 kWh. Altogether, the cuts which came into effect in November have enabled an extra 8 million kWh to be used for domestic heating, which was very necessary owing to the intense cold and almost complete absence of domestic coal. It is pointed out that the cuts have not contributed to a reduction in the level of industrial production. Where factories have had to be closed down this was due to lack of coal and not lack of electricity. It has been suggested that it would benefit industrial production if more coal were allocated for domestic heating. Electric heating uses a great deal of coal, the 8 million kWh for domestic heating having cost 8000 tons of coal a day. It is calculated that an allocation of 2000 tons of coal to domestic consumers for direct use in ovens or stoves would save the consumption of 8000 tons in thermal plants. This would result in an economy of 6000 tons of coal for each cold day, and this coal could be delivered to non-priority industries to save them closing down.

The record consumption was satisfied following further effort from thermal plants which produced a total of 48,700,000 kWh against the previous maximum of 48,500,000 kWh. Thermal production for the Paris region was 18 million kWh, of which 1,800,000 kWh went to other regions. Hydraulic production was 28,200,000 kWh. Reservoirs remain 48 per cent full.

Notes and Memoranda

Air and Water

RETIREMENT OF MR. W. J. BELSEY.—Mr. W. J. Belsey retired from the British Thomson-Houston Company, Ltd., shortly before the end of last year, after completing forty-four years of service. He was well known as the manager of the marine department of the firm, which he served from its inception until his retirement from that office in 1944. Since that date until his retirement he remained with the company in a consulting capacity.

CHANNEL ISLANDS AIRWAYS.—During the past year from January 1st to December 31, 1946, a total of 74,646 passengers, 883,232 lb of cargo and 546,837 lb of Post Office mail was carried by Channel Islands Airways. In addition, over 1,500,000 miles have been flown in 13,000 flying hours and 12,861 flights completed. From the inauguration of air services to the Channel Islands on December 18, 1933, to the end of last year, 272,853 passengers have been carried.

K.L.M. ENGINE REPAIRS AT SCHIPOL.—A new K.L.M. engine maintenance workshop, covering some 7000 square feet, was opened on January 6th at the Schipol airport near Amsterdam. It replaces that destroyed by the retreating Germans and is equipped with the most modern machinery. For some time this important work was done in a small garage in Amsterdam, with improvised tools and equipment, and the technical stores and propeller overhaul workshop were located in nearby temporary premises.

RECONVERSION OF THE "CAPETOWN CASTLE."—On Thursday, January 9th, the Union-Castle Line's 27,000 gross ton motor passenger liner "Capetown Castle," which has been reconverted by her builders, Harland and Wolff, Ltd., at Belfast, sailed from Southampton with 750 passengers on board. During her seven years of war service she steamed 500,000 miles and carried 164,000 troops. Her valuable fittings and furnishings have now been restored and as a two-class ship she carries 250 first-class and 500 cabin-class passengers. The main propelling and auxiliary machinery has been thoroughly overhauled.

MARINE RADAR.—Following the International Meeting held in London in May last on Radio Aids to Marine Navigation, a report on the proceedings was recently published. A second volume based on the scientific and technical documents presented at the meeting has now been prepared by the Ministry of Transport and is published by the Stationery Office under the title of "Radio Navigation, Radar and Position Fixing Systems for Use in Marine Navigation," price 5s. All radio aids, either in existence or under development, are surveyed. Radio direction finding is dealt with and hyperbolic systems of navigation, such as the Loran, Gee and Decca and others are described. A special section is devoted to marine radar in all its forms as a ship-borne instrument, as a shore installation for harbour supervision and for radar beacons. A specification for a ship-borne radar set has been drawn up. The new volume should prove of interest to all who are in any way concerned with radio aids to marine navigation.

Miscellanea

THE LATE MR. S. H. RICHARDS.—We record with regret the death, on January 9th, of Mr. S. H. Richards, M.I.E.E., who was Chief Meter Examiner to the Electricity Commissioners. Mr. Richards was appointed on March 1, 1937, following the passing of the Electricity Supply (Meters) Act, 1936, and had been generally responsible to the Commissioners for the duties laid upon them under that Act.

OVERSEAS TECHNICIANS STUDY IN BRITAIN.—The British Council has awarded for the current academic year some seventy scholarships to graduates and others of like standing from Empire and foreign countries to enable them to study scientific and technical subjects, including engineering, mining and agricultural services, in this country. Most of these scholarship holders are at the universities and technical colleges. Others are studying at or in co-operation with the Southern Railway, Gaumont British Instructional Films, Croydon Borough Engineering Department and the B.B.C. Subjects of study include chemistry, engineering, geomagnetism, mining physics, tanning, textiles, wood products and building. In addition to providing these scholarships, the British Council advises and helps to place many students from overseas who are sent by their Governments and other bodies or who come privately.

ATOMIC POWER FILM.—By courtesy of Twentieth Century Fox Film Company, Ltd., the "March of Time" film, entitled "Atomic Power," is being shown daily in the Lecture Theatre of the Science Museum, South Kensington, S.W.7, free of charge. The film, which tells the story of the way in which atomic energy has been released and utilised, is being shown on weekdays at 2.30 p.m. and on Sundays at 3.15 and 4.15 p.m. until January 26th.

A STUD WELDING DEMONSTRATION VAN.—We are informed by Cooke and Ferguson, Ltd., Victoria Street, Openshaw, Manchester, 11, that the company has fitted out a demonstration van with a suitable motor-driven generator and complete welding unit to demonstrate the Nelson stud welding process in any part of the country. All that is required to demonstrate the process, which was briefly described in THE ENGINEER of October 25, 1946, is a 440-volt, three-phase supply of current. A complete range of samples of all types of studs is carried in the van, and the engineer in charge of it is fully qualified to deal with all inquiries relating to stud welding.

A SHALE MINE EXPLOSION.—It is with the deepest regret that we have to record the death of fifteen miners as a result of a serious explosion which occurred in the Burngrange Shale Pit, near West Calder, Midlothian, on Friday night, January 10th. One man was killed while groping his way to safety after the explosion, and the fourteen others were not reached until Tuesday, despite continuous rescue operations. The entombed men were untouched by the fire which raged in the pit, and death appeared in all cases to have been caused by gas fumes. The mine belongs to Young's Paraffin Light and Mineral Oil Company, a subsidiary of Scottish Oils and Shell Mex. It was sunk about ten years ago and is looked upon as the most modern mine in the British shale oil industry.

COPPER, LEAD AND ZINC PRICES.—With reference to the recent announcement of new selling prices of copper, lead and zinc as from January 1, 1947, the Ministry of Supply now states the withdrawal of the notification that holders of outstanding licences (for copper, lead and zinc metal as sold by the Directorate of Non-Ferrous Metals) granted on or before December 31, 1946, would only be covered at the new prices. Following discussions with the British Non-Ferrous Metals Federation, the Ministry is prepared to consider covering these outstanding licences at the prices ruling on December 31st. Holders of such licences (including those who have, since January 1st, converted their licences into contracts at the new prices) should apply to the Directorate of Non-Ferrous Metals, 20, Albert Street, Rugby, not later than January 21st.

NEW GENERATING PLANT.—A useful contribution towards increased production of power station generating plant is being made by the Witton engineering works of the General Electric Company, Ltd. Towards the close of last year a 30-MW G.E.C. set was installed and placed on load in the Sculcoates generating station, Hull. More recently, the 65-ton stator for another 30-MW turbo-alternator (the first of four similar sets aggregating 120 MW) was delivered at the Meaford power station of the North-West Midland J.E.A. Within the next two or three weeks the stator for the second of these sets will be ready to leave the Witton works. The whole of the power plant and switchgear for Meaford is being supplied by the G.E.C. and, in addition to the first stator, two 33-MVA, 132/11-kV transformers have already been delivered.

SHEET METAL USERS' CONFERENCE.—The winter conference of the Sheet and Strip Metal Users' Technical Association is to be held in London on Friday and Saturday, January 31st and February 1st. The technical sessions will take place at the Waldorf Hotel, Aldwych, W.C.2, from 10 a.m. to 4 p.m. on the Friday and from 9.30 a.m. to 12 noon on Saturday morning. The subjects to be dealt with at these technical sessions are:—"Solders and Soldering Practice," by Mr. R. G. Harper; "Flame Spraying by the Powder Pistol," by Dr. W. D. Jones; "The Welding of Steel, with Special Reference to Hardenability," by Monsieur H. Granjon; "Fundamental Principles in Resistance Welding of Sheet Metal," by Mr. H. Dixon; and "Development of Zinc Alloy Tools for Blanking and Raising in Mechanical Presses," by Mr. K. Hayward. The Association's banquet will be held at the Café Royal, Regent Street, W.1, on Friday evening, January 31st, at 7 p.m. for 7.30 p.m. Further particulars of the conference may be obtained from the Secretary the Association, 49, Wellington Street, London, of W.C.2.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Tuesday, Jan. 28th.—MANCHESTER BRANCH: Reynolds Hall, College of Technology, Manchester. "Fuel Efficiency in the Chemical Industry," A. C. Dunningham. 3 p.m.

Association of Supervising Electrical Engineers

Tuesday, Jan. 21st.—Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Delicolor Equipment," E. E. Faraday. 6.15 p.m.

Bradford Engineering Society

Monday, Jan. 20th.—Technical College, Bradford. "Valve Design," E. A. B. Greaves. 7.15 p.m.

Chemical Society

Thursday, Jan. 23rd.—LIVERPOOL BRANCH: University, Liverpool. "Metabolic Cycles," H. A. Krebs. 5 p.m.—SOUTH WALES BRANCH: University College, Swansea. "The Absorption of Light," E. J. Bowen. 6 p.m. (Joint meeting.)

Thursday, Jan. 30th.—SHEFFIELD BRANCH: The University, Sheffield. "Some Relationships Between the Structure and Properties of Natural and Synthetic Fibres," J. B. Speakman. 5.30 p.m.

Institute of Marine Engineers

Monday, Jan. 20th.—JUNIOR SECTION: University of London, King's College, Strand, W.C.2. "Gas Turbines and their Prospects," S. J. Davies. 6 p.m.

Institute of Physics

To-day, Jan. 17th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. "Sonic Methods in Non-Destructive Testing," R. Meakin. 6.30 p.m.

Institute of Welding

Saturday, Jan. 18th.—W. SCOTLAND BRANCH: North British Station Hotel, George Square, Glasgow. Annual luncheon. 1 p.m.

Wednesday, Jan. 29th.—Inst. of Civil Engineers, Great George Street, S.W.1. Discussion, "Future Ships—Will they be All-Welded?" 6 p.m.

Institution of Automobile Engineers

Wednesday, Jan. 22nd.—12, Hobart Place, S.W.1. "Twin-Piston, Two-Stroke Engine Design," J. Ehrlich. 6.30 p.m.

Tuesday, Jan. 28th.—BIRMINGHAM BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "The Road Manners of the Modern Car," Maurice Olley. 6.30 p.m.

Thursday, Jan. 30th.—DERBY BRANCH: School of Arts, Green Lane, Derby. "Some Problems of Cylinder Bore Wear," W. A. Robotham. 7 p.m.

Institution of Civil Engineers

Tuesday, Jan. 21st.—Great George Street, S.W.1. "A New Piling Formula," Oscar Faber. 5.30 p.m.

Friday, Jan. 31st.—YORKSHIRE ASSOCIATION: Great Northern Station Hotel, Leeds. Twenty-sixth annual dinner. 7 p.m.

Institution of Electrical Engineers

Saturday, Jan. 18th.—N. MIDLAND STUDENTS: Corporation Electricity Department, Whitehall Road, Leeds. Chairman's Address, A. G. Connell. 2.30 p.m.

Monday, Jan. 20th.—MERSEY AND N. WALES CENTRE: Liverpool Royal Institution, Colquitt Street, Liverpool. "A Survey of the Development of Radar," R. A. Smith. 6 p.m.

Tuesday, Jan. 21st.—N. WESTERN CENTRE (TRANSMISSION GROUP): Engineers' Club, Albert Square, Manchester. "Three-Phase Distribution and Electric Welding and Furnace Loads," A. Langley Morris. 6 p.m.—RADIO SECTION: Savoy Place, Victoria Embankment, W.C.2. Discussion, "Radio Versus Line for Communications Systems," opened by A. H. Mumford. 5.30 p.m.

Thursday, Jan. 23rd.—INSTALLATIONS SECTION: Savoy Place, Victoria Embankment, W.C.2. "The High-Pressure Mercury-Vapour Discharge and its Applications," V. J. Francis and W. R. Stevens. 5.30 p.m.

Friday, Jan. 24th.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. "The Application of Electrical Technique to the Service of Some Other Industries," H. Cobden Turner and G. M. Tomlin. 5.30 p.m.

Tuesday, Jan. 28th.—N. MIDLAND CENTRE (INSTALLATIONS GROUP): Corporation Electricity Department, Whitehall Road, Leeds. "Engineering Principles Applied to the Design of Domestic Water Heating Installations of the Solid Fuel Electric Type," R. Grierson and Forbes Jackson. 6 p.m.

Wednesday, Jan. 29th.—SCOTTISH CENTRE: Heriot-Watt College, Edinburgh. "The Analysis of Vibration Problems," A. J. King. 6 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Jan. 21st.—39, Elmbank Crescent, Glasgow. "Longitudinal Bending Moments in Ships," J. M. Murray.

Institution of Factory Managers

Saturday, Jan. 25th.—Waldorf Hotel, Aldwych, W.C.2. Annual general meeting. 2.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 17th.—Storey's Gate, St. James's Park, S.W.1. "Recent Developments in Flying-Boats," H. Knowler. 5.30 p.m.

Monday, Jan. 20th.—MIDLAND GRADUATES: James Watt Memorial Institute, Great Charles Street, Birmingham. Chairman's Address, "Making the Modern Motor Tyre," H. Devey. 7 p.m.

Friday, Jan. 24th.—Storey's Gate, St. James's Park, S.W.1. "Materials New to Engineering," F. T. Barwell. 5.30 p.m.

Saturday, Jan. 25th.—GRADUATES SECTION: Storey's Gate, St. James's Park, S.W.1. "Coal Mining and the Mechanical Engineer," W. J. Drummond. 3 p.m.

Friday, Jan. 31st.—Storey's Gate, St. James's Park, S.W.1. "The Life of Carbide-Tipped Turning Tools," F. F. P. Bisacre and G. H. Bisacre. 5.30 p.m.

Institution of Post Office Electrical Engineers

Wednesday, Jan. 22nd.—Faraday Building (9th Floor), Knightrider Street, E.C.4. "Auto Exchange Maintenance," A. Hudson, E. A. Smith and F. S. Hyatt. 5 p.m.

Institution of Production Engineers

To-day, Jan. 17th.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol. "Crushing Wheels for Form Grinding," G. H. Ashbridge. 6.45 p.m.

Monday, Jan. 20th.—N. EASTERN SECTION: Neville Hall Mining Institution, Newcastle-on-Tyne. "Profile Machining," N. J. Cooke; "Preventive Maintenance of Machine Tools," F. Ward. 6.30 p.m.—DERBY SUB-SECTION: Art School, Green Lane, Derby. "Hydraulics as Applied to Machine Tools," W. Whitworth Taylor. 6.45 p.m.

Wednesday, Jan. 22nd.—PRESTON SECTION: Harris Institute, Avenham, Preston. "The Training of Apprentices," V. W. Pilkington. 7.15 p.m.—MANCHESTER SECTION: College of Technology, Manchester. "Factory Inspection," H. E. Chastney. 7.15 p.m.

Thursday, Jan. 23rd.—HALIFAX GRADUATES: Technical College, Huddersfield. "Recent Developments in Die Castings," H. W. Fairbairn. 7 p.m.

Friday, Jan. 31st.—E. COUNTIES SECTION: Lecture Hall, Electric House, Ipswich. "Production Methods as Applied to Machine Tools," T. P. N. Burness. 7.15 p.m.—LINCOLN SUB-SECTION: Technical College, Lincoln. "Education and the Apprentice," E. R. Walter. 6.30 p.m.

Institution of Sanitary Engineers

To-day, Jan. 17th.—Caxton Hall, Westminster, S.W.1. "The Metropolitan Water Board," H. Berry. 6 p.m.

Institution of Structural Engineers

Thursday, Jan. 23rd.—11, Upper Belgrave Street, S.W.1. "The Stress Grading of Timber and its Influence on Structural Design," E. H. Nevard. 6 p.m.

Newcomen Society

Wednesday, Jan. 22nd.—MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "History of the Staffordshire Thick Coal Seam," F. T. Perrins. 5.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Jan. 17th.—Mining Institute, Newcastle-on-Tyne. "Application of Modern Management Methods to the Shipbuilding Industry," F. A. J. Hodges. 6 p.m

North-Western Fuel Luncheon Club

Wednesday, Jan. 22nd.—Engineers' Club, Albert Square, Manchester. "The Ups and Downs of Aviation," Sir Roy H. Dobson. 12.30 p.m.

Royal Aeronautical Society

Thursday, Jan 30th.—Inst. of Civil Engineers, Great George Street, S.W1. "Wartime Developments in Air Transport," Sir Ralph Cochrane. 6 p.m.

Royal Society of Arts

Wednesday, Jan. 22nd.—John Adam Street, Adelphi, W.C.2. "Gas Turbines," Sir Claude Gibb. 5 p.m.

Sheffield Society of Engineers and Metallurgists

Monday, Jan. 20th.—Royal Victoria Station Hotel, Sheffield. "Recent Developments in the Aluminium Industry," C. J. Smithells. 6.15 p.m.

Stephenson Locomotive Society

Saturday, Jan. 18th.—MANCHESTER BRANCH: Manchester Geographical Society Rooms, St. Mary's Parsonage, Manchester. "Webb Compound Locomotives of the L.N.E.R.," B. Baxter. 6.15 p.m.

Contracts

THE GENERAL ELECTRIC COMPANY, Ltd., has received contracts for lighting schemes on airfields at Hato and Dakota, situated on the islands of Curacao and Aruba, Netherlands West Indies.

STANDARD TELEPHONES AND CABLES, Ltd., has secured an order from the Posts and Telegraphs Department of the Turkish Administration for long-distance radio telephone and telegraph communication equipment. The order provides for two major radio stations at Ankara and Istanbul respectively, which will give facilities for telephone links with London and New York. The stations also provide for an extensive system of radio telegraphy operating from Turkey to Europe, America and the Near East. The value of the order is approximately £400,000.

ORDERS totalling more than £630,000 are being placed by the London, Midland and Scottish Railway with the British motor industry under a programme for the provision during 1947 of 940 new road vehicles and 625 trailers. The programme includes over 500 "mechanical horse" tractors, 300 goods and parcels vehicles and 100 service cars. More than 200 of the new vehicles will replace horse-drawn transport; the remainder will augment the L.M.S. road motor fleet for the development of peacetime traffic and to make good arrears caused by the war.

Personal and Business

MR. A. H. HIND has been appointed a director of Vickers-Armstrongs, Ltd.

SIR HOLBROOK GASKELL has retired from the board of Imperial Chemical Industries, Ltd.

MR. ROBERT HOWATT has been appointed chief engineer of the Steel Company of Scotland, Ltd.

MR. C. W. RICHARDSON has been appointed assistant engineer of W. R. Sykes Interlocking Signal Co., Ltd.

MR. GEORGE IRVING, Midlands and West Country representative of Walworth, Ltd., has retired after fifty-six years' service with the company.

ENGINEER REAR-ADMIRAL F. V. KING has been appointed technical consultant for the shipbuilding and marine interests of Tube Investments, Ltd.

LIEUT.-COLONEL H. RIGGALL has been re-elected President of the British Engineers' Association. Mr. C. K. F. Hague and Mr. K. Fraser have been elected vice-presidents.

THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, LTD., has changed its branch office address to Lambton House, Lambton Road, Newcastle-upon-Tyne, 2 (telephone, Newcastle-upon-Tyne 23395).

THE BRITISH ALUMINIUM COMPANY, LTD., announces the appointment of Mr. F. W. Osborn as Midland branch manager at Lansdowne House, 41, Water Street, Birmingham, 3 (telephone, Birmingham Central 3053).

CROSSLEY BROTHERS, LTD., and CROSSLEY-PREMIER ENGINES, LTD., have changed their London address to Langham House, 308, Regent Street, W.1 (telephone, Langham 3217; telegrams, Crossley Brothers, phone, London).

THE COLONIAL OFFICE announces the following appointments: Mr. P. M. M. Townsend, executive engineer, Public Works Department, Nigeria; and Captain W. H. French, engineer in the Posts and Telegraphs Department, Nigeria.

MR. H. N. EDWARDS has been appointed a special director of the Metropolitan-Cammell Carriage and Wagon Company, Ltd. Whilst Mr. A. J. Boyd, managing director, is abroad on the company's business, Mr. Edwards will act on his behalf.

MR. W. J. DRUMMOND, M. Inst. C.E., M.I.Mech.E., deputy chairman of the North-Western Divisional Coal Board, has been appointed honorary secretary of the British National Committee of the World Power Conference, in succession to the late Mr. C. Rodgers.

DEWRANCE AND CO., LTD., announces that branch offices have been opened at 148-9, Great Charles Street, Birmingham, 3 (telephone, Birmingham Central 2176), and at Mynshulls House, 14, Cateaton Street, Manchester, 3 (telephone, Manchester Blackfriars 9451).

SIR ROBERT WATSON-WATT has relinquished his full-time appointments as Vice-Controller of Communications Equipment under the Ministry of Aircraft Production and Scientific Adviser on Telecommunications under the Air Ministry. Sir Robert is taking up private work, but he will also continue to devote part of his time to consultant work for the Government, and will act as Scientific Adviser on Telecommunications to the Ministry of Supply, Air Ministry, Ministry of Civil Aviation and Ministry of Transport.

A NEW company, Chance-Londex, Ltd., with a capital of £10,000, has just been formed, the objects of which are the manufacture, marketing and servicing of battery-operated navigational and marine lights, fog signals, loud speakers, radio location apparatus, &c. Queries which are received by Chance Brothers, Ltd., for marine lighting equipment where battery-operated apparatus can be offered will be referred to Chance-Londex, Ltd., and Chance-Londex, Ltd., will refer to Chance Brothers, Ltd., any enquiries which it receives and for which battery-operated equipment is unsuitable.

Calendars and Diaries

BROWN BOVERI, Baden, Switzerland.

BUTTERLEY COMPANY, Ltd., 2 Caxton Street, S.W.1.

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A Seven-Day Journal

The Manchester Joint Research Council

At the annual general meeting of the Manchester Joint Research Council, held in Manchester University on Monday, January 13th, Mr. A. H. S. Hinchliffe, D.L., was unanimously re-elected chairman, and Sir John B. Stopford, F.R.S., honorary treasurer, for a further year of office. Mr. E. A. Carpenter, Sir William Clare Lees, Bart., Mr. John S. Dodd, Professor J. Jewkes, Professor A. H. Gibson, Mr. Frank Longworth, Dr. J. E. Myers, Mr. Charles G. Renold, Sir E. Raymond Streat, and Mr. John F. West were re-nominated by their respective organisations to serve on the Council for a further period of three years. Several meetings of the Council, the Executive Committee and the Management Committee took place during the year. A successful conference was held in October on "Research and the Smaller Firm" and was attended by over 200 members and visitors. During the year the chairman visited London and addressed the Parliamentary and Scientific Committee, outlining the scope and functions of the Council. Considerable use is being made of the library of reports on German industry. At one time it was hoped that local industrialists might be permitted to visit Germany to study more closely the technical and manipulative details of processes in which they are interested, but so far the response from the Government Department concerned has not been as encouraging as it might have been. A movement similar to the Manchester Joint Research Council is being considered by members of the Leeds Chamber of Commerce and the staff of the Leeds University. Manchester University has informed the Council with regard to the scope of its research work for the benefit of inquirers. A market research conference is proposed and three leading firms have offered their assistance. The Council's survey of graduate employment in the Greater Manchester area has attracted considerable attention, and further information has been asked for.

The Late Lord Southborough

Many of our older engineers will learn with regret of the death, in London, on Friday, January 17th, of Lord Southborough, at the age of eighty-six. He started life as a civil servant, but had much to do with railway and transport work, and in 1926 was the chairman of Sir W. G. Armstrong, Whitworth and Co. Sir Francis John Stephens Hopwood, the first Baron Southborough, was educated at Louth and was admitted a solicitor in 1882. Three years later he joined the Board of Trade and in 1888 he became assistant solicitor. In 1902 he was appointed private secretary to the President, and later he was given charge of the railway department, a position he held until 1901. During those years he attended the International Railway Congresses in London and Paris. In 1901 he was appointed Permanent Secretary to the Board of Trade. He was a member of the London Traffic Commission and the Commission on Ocean Freights and Shipping Rings of 1906. In 1907 he left the Board of Trade and became Permanent Under-Secretary of State for the Colonies, a position he held with honour until 1911. He received the C.M.G. and, later, the K.C.M.G., the C.B. and the K.C.B. in recognition of his work for the nation. In 1912 he became Civil Lord of the Admiralty and had to do with naval contracts. He was Chairman of the War Trade Advisory Committee in the early years of the 1914-1918 war, and in 1917 was Secretary to the Irish Convention. In that year he was raised to the peerage and was awarded the G.C.V.O. In 1918 he was sent to India on matters relating to the Indian franchise, and after his Committee had reported in 1919 he received in 1920 the K.C.S.I. On retiring from Government service he was free to take up other duties and served on the Committee of the National Physical Laboratory. In 1926 he took the chairmanship of Sir W. G. Armstrong, Whitworth and Co. and served that company well during difficult years. He was a director of the London Underground Electric Railways and several other companies. He will long be remembered as a man of wide knowledge, whose services to his country were very great.

Taxation Policy 1947-1948

The following statement by the Federation of British Industries, which has been unanimously approved, has been forwarded to the Chancellor of the Exchequer, with a request that he should receive a joint deputation of the Federation and the Association of British Chambers of Commerce. The following recommendations are put forward in connection with the forthcoming Budget: That taxation should be substantially reduced, even at the cost of a temporarily unbalanced Budget; that the reduction should be concentrated on direct taxation, but should, above all, be designed to encourage production; that no special tax should be imposed upon business profits, but, on the contrary, the Profits Tax (N.D.C.) should be repealed; that there should be a special enquiry into the efficiency of the national expenditure. When, last year, the Federation put forward its views on taxation, it pointed to the primary need to encourage production, and discussed also the questions of economy in national expenditure and a Budget balance. It believes the need to encourage production is even more urgent to-day. Greater production would make the task of achieving a balanced Budget easier, but high taxation is, it is claimed, proving a hindrance by weakening incentives to production. Production, it is pointed out, is a matter of human effort and efficient organisation, allied with equipment. Industry in general requires re-equipment, but at the moment this is impossible on a substantial scale. That fact is true, alike for the machine producing industries, and for the industries which use the machines. The leeway left by a long war has to be made up at the machine producing end before it can be overtaken at the using end. Some time must inevitably, therefore, elapse before re-equipment at the using end can be completed. Greater production with the existing equipment must, the Federation states, be the immediate aim. The memorandum and statement further deals with such subjects as the income, the purchase, and the profit taxes, while national economy and Budget balance or deficit are discussed. Some taxation anomalies dealt with include those affecting buildings, terminal expenses, E.P.T. cancellation costs, industrial buildings, and stock valuations.

Permanent Way Problems

In his speech at the annual dinner of the Permanent Way Institution, which took place in London, on Saturday, January 18th, Mr. G. R. Strauss, Parliamentary Secretary to the Ministry of Transport, dealt with permanent way difficulties. The present position was, he said, that before the war our railways used on an average just about four and one third million sleepers a year. During the war, the average input had to be reduced to just under three million sleepers, and by 1946 arrears of nearly ten million sleepers had accumulated. In order to wipe off those arrears in five years, two million sleepers per year were needed, in addition to which a further four million were needed for maintenance, making a total of six million sleepers per year. There was, Mr. Strauss said, not the slightest chance of our being able to carry out a programme of that magnitude. He went on to explain that whereas before the war we used to import sleepers from Russia, the Baltic countries, Canada and America, we were now practically wholly dependent on Canadian and United States sources. Our stocks of sleepers, too, had declined. Before the war we used to maintain a stock of three to four million sleepers, and a nine months' period of seasoning was allowed. We were now down to the dangerously low figure of half a million, which, he feared, might still be reduced. Steel and cast iron sleepers being ruled out, there was only the concrete sleeper, of which he said the pre-stressed sleeper was the only one which would stand up to heavy main line traffic. Production of concrete sleepers was, he said, being stepped up to a target figure of a million a year, but he feared that nothing like that quantity could possibly be produced in 1947. New rails were also short. Before the war our average intake of rails was 211,000 tons. During the war this was reduced to 157,000 tons, and a substantial deficit has accumulated. Owing to steel shortage, it was expected that there would be an overall shortage of supplies, compared with demands, of half a million tons in the first quarter of 1947 alone. It would, therefore, be impossible this year, to meet the steel needs and the timber needs of the permanent way. In spite of these difficulties, the engineering departments of our railways had set and achieved such a high standard of maintenance that their effects had been minimised. He suggested that the constant aim of all concerned should be, as he knew it was, to use all experience, skill and ingenuity in order to regain, as soon as possible, our pre-war standards.

Faraday Medal Award

The Council of the Institution of Electrical Engineers has made the twenty-fifth award of the Faraday Medal to Sir Standen Leonard Pearce, C.B.E., D.Sc., a Past-President of the Institution for his outstanding contribution to the advancement of engineering practice, and notable achievements in electrical engineering. Sir Leonard was educated at Bishops Stortford College, and Finsbury Technical College, London, and he served his pupilage with J. G. Statter and Company, at West Drayton, and Thomas Richardsons, Ltd., at West Hartlepool. In 1894 he joined the staff of the British India Steam Navigation Company, Ltd., and later, in 1896, was appointed an assistant engineer to the Metropolitan Electricity Supply Company. Following an appointment with the British Thomson-Houston Company, Ltd., he became, in 1900, superintendent engineer at the power station of the Central London Railway. In 1901 he was appointed deputy chief electrical engineer at Manchester, and in 1903 was selected for the position of chief engineer to the Manchester Corporation Electricity Undertaking. In 1925 he became an Electricity Commissioner, and the following year left in order to take up the position of engineer-in-chief to the London Power Company. From 1940 until 1945 he again served as Electricity Commissioner, whilst retaining his position with the London Power Company. He is a valued member of the Institution of Electrical Engineers, and was elected a Vice-President in 1920. Sir Leonard is also a member of the Institution of Civil Engineers, and was a Past-President of the Manchester Section. He is a Past-President of the Incorporated Municipal Electrical Association, and the Junior Institution of Engineers. He is a Member of the Institution of Mechanical Engineers, and gave the Thomas Hawksley Lecture before the Institution in 1940. The Barton Power Station, Manchester, was designed by Sir Leonard who, was later responsible for the design and operation of the Battersea Power Station. The Council of the Institution of Electrical Engineers also announces that it has elected Sir John Macfarlane Kennedy, Past-President, to be an Honorary Member of the Institution, in recognition of his distinguished work in the sphere of electricity supply, and of his services to the Institution.

Water Treatment and Filtration Plant at Chicago

By E. E. R. TRATMAN

No. I

PROMINENT among numerous important engineering works in progress for the City of Chicago, U.S.A., is the new water conditioning and filtration plant to serve the water supply of the southern section of the city. This plant is one of the largest—perhaps the largest—yet built. It is designed for an hourly peak capacity at the rate of 450 million gallons daily. At the nominal filtering rate of 125 million gallons per acre, or two gallons per square foot per minute, the capacity of the plant is 320 million gallons daily. With allowance for variations of weather and temperature, the filtration rate may range from two to four gallons per square foot per minute, the special treatment devised permitting higher rates than are generally used in water filtration.

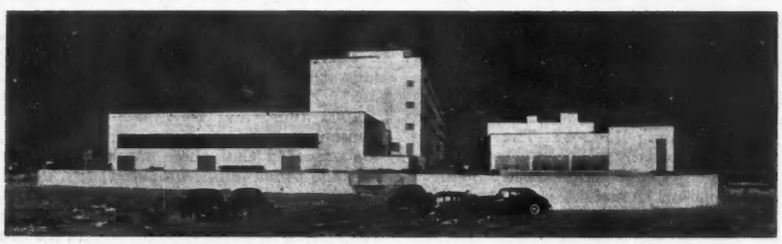


FIG. 1—WATER TREATMENT PLANT AT CHICAGO

A remarkable feature of the plant is its comprehensive character. While its main purpose is the filtration of a polluted water, it provides also for a variety of chemical treatments and other processes preparatory to or supplementary to the filtration, or for chlorine treatment independent of the filtration. Two similar plants are contemplated to serve the central and northern sections of the city.

A view of part of the plant under construction is shown in Fig. 1. It is situated on the shore of Lake Michigan. The general arrangement of the several departments is explained by the plan, Fig. 2, together with the typical longitudinal section in Fig. 3.

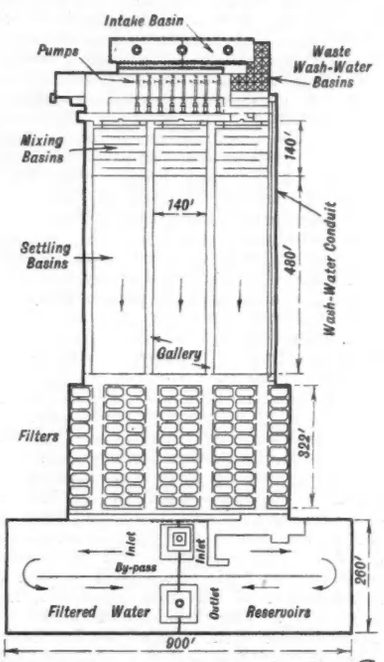


FIG. 2—LAY-OUT OF WATER TREATMENT PLANT

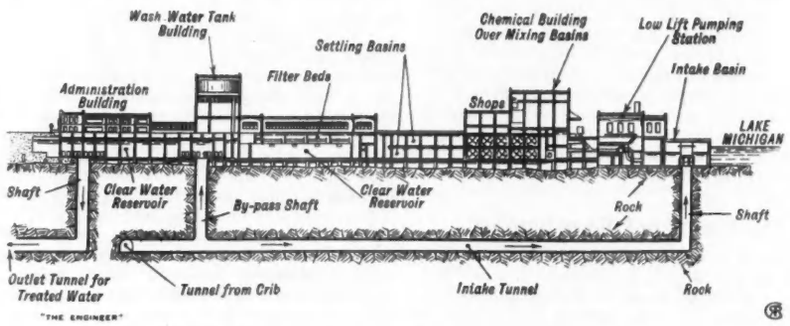


FIG. 3—LONGITUDINAL SECTION THROUGH BASINS AND FILTERS

CITY WATER SUPPLY

For clear understanding of the complicated situation of the purification of a polluted water, it is necessary to explain the water supply system of Chicago. Interlocking problems of providing both pure water and innocuous disposal of sewage and wastes have been troublesome features in the rapid growth and industrial development of the city.

Situated at the mouth of the Chicago River, on the west side of Lake Michigan, the city has, close at hand, a magnificent source of water supply. The lake is some 300 miles long and 80 miles wide and has a maximum depth of 870ft. The surface area is 22,000 square miles at an elevation of 582ft above sea level. But in its early days the city began the pollution of the lake by discharging into it the local sewage and wastes, either directly or by way of the river. The city's population has grown from 300,000 in 1870 to 3,400,000 in 1940.

With the manufacturing and general industrial development of Chicago there has been a great increase in the volume and variety of trade wastes in addition to the domestic sewage. In recent decades, also, this pollution of the lake has been aggravated greatly by sewage from a group of lake-front cities south of Chicago and also by trade wastes from numerous manufacturing plants in the same vicinity. Prevailing winds and currents tend to drift this polluting matter into that part of the lake from which Chicago draws its water supply. This objectionable condition applies specially to the southern section of the city, which, with an area of 115 square miles (or 54 per cent of the total area), has a population of 1,400,000 (or 38 per cent of the total population).

Lake water was taken at first by a suction pipe leading from a pumping station and laid on the bed of the lake. But as the water near shore soon became contaminated, the present system was adopted some eighty years ago. This system consists essentially in sinking intake shafts in deep water and driving tunnels under the lake to connect the shafts with pumping stations on land. This arrangement is shown typically in Fig. 4, while the map, Fig. 5, shows the existing intakes, tunnels and pumping stations. In this map, the shaded area indicates the southern section of the city, the water supply of which is served

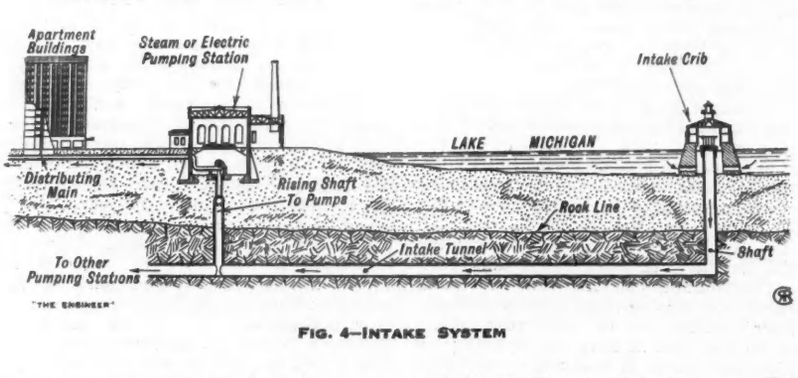


FIG. 4—INTAKE SYSTEM

by the new treatment plant and the three pumping stations at 68th Street, Roseland and Western Avenue.

From the bed of the lake the shaft is extended up through the water in the form of a steel cylinder, which rises above the water level. This head of the intake shaft is surrounded by a circular structure termed locally a "crib," the earlier of these structures being formed largely of timber cribbing. The more recent cribs are of masonry construction, with steel superstructures. Ports or openings in the crib wall admit water into the enclosed well, in the centre of which rises the steel shaft cylinder, having regulating gates in its sides.

FIG. 5—MAP OF CHICAGO WATER SUPPLY SYSTEM

The first of these lake intakes was built in 1867, the shaft being two miles from shore and connected with the pumping station on land by a rock tunnel 5ft in diameter. There are now six intakes and cribs, from two to three miles off shore, in water 20ft to 35ft deep. They serve twelve pumping stations and connect with 63 miles of submarine and land tunnels, 5ft to 16ft in diameter, mainly in solid rock. Distributing pipe mains served by the tunnels and pumping stations aggregate a network of 4000 miles of pipe. Attendants live in quarters on the cribs to operate the gates and navigation lights and to keep the gates clear of ice in winter.

CHICAGO DRAINAGE CANAL

A bold project initiated in the early 1890's for the purpose of solving the pollution problem, was the reversal of the flow of the Chicago River by cutting a canal through a shallow ridge or divide of its drainage area. Thus polluted lake water was able to flow inland through the Chicago, DesPlaines, Illinois and Mississippi rivers, eventually discharging into the Gulf of Mexico, and being purified by increasing dilution during its long travel. Equally bold was the plan to construct this channel as a ship canal, to form a link in an inland navigation route connecting the Great Lakes with the Gulf. It is so used now, and during the recent war many navy craft of the smaller class were built at lake ports and transferred to salt water by this route.

Water was admitted to the canal on January 2, 1900, and a flow of 5000 cubic feet per second was established. Later, shipping interests on the Great Lakes made strong opposition to this volume of withdrawal, on the controversial basis that it would lower the water level of the lakes and cause trouble to the lake ports. Suits to reduce or stop the withdrawal passed from court to court, until, in 1930, the Supreme Court of the United States limited the average diversion to a flow not exceeding 1500 cubic feet per second. This amount was considered by the sanitary authorities to be entirely inadequate for purification of the water by dilution, especially in view of the continuing and increasing pollution of the lake. At present, however, the above limitation remains in force.

Meanwhile, to eliminate its own share of the pollution, the City of Chicago built a system of intercepting sewers to prevent the discharge of sewage into the river or the lake, and also built extensive and costly works for the treatment of sewage before its discharge into any watercourse. However, the cities and industrial works further south were, and are, still adding to the pollution. Legal action has been taken and litigation is in progress to halt this pollution, but progress is slow, although some of the offenders have been ordered by the courts to establish sewage treatment works. The net result of all these proceedings was that the problem of providing a safe and palatable water supply for Chicago remained unsolved. Attention was thus directed again to the possibilities and advantages of filtration.

EARLIER WATER TREATMENT

On account of the increasing contamination of the lake water, sterilisation at the intake cribs was begun in 1912, as a means of protection against water-borne diseases, such as typhoid fever and other intestinal disorders. This treatment consisted in chlorination of the inflowing water. But it did not purify the water and did not remove dirt or other foreign matter. As a protection from heavy pollution at the Dunne and 68th Street intake cribs, a plant for chlorine-ammonia treatment was installed, in 1936, at the Dunne crib to treat the water from these two lake intakes, which were about 200ft apart. Prior to this, the water from these intakes had been chlorinated at the three pumping stations supplied from these cribs and supplying the southern section of the city. In 1939, the crib chlorination was supplemented by additional chlorination at the pumping stations.

The pumpage at these pumping stations aggregates an average of 335 million gallons daily, or from 312 m.g.d. in cold weather to 429 m.g.d. in hot summer weather. The 68th Street crib and its 5ft tunnel were abandoned in 1945. The Dunne crib has its 14ft tunnel now connected with the new filtration plant, two miles away, by a 16ft tunnel in order to serve as a standby or alternative source of water supply.

(To be continued)

The Compression-Condensation Cycle

By OLIVER LYLE

THE article by Mr. Holcroft, which was published in THE ENGINEER of September 6, 13 and 20, 1946, appears, from the correspondence columns, to have excited interest. It seems worth while therefore to examine theoretically the compression-condensation cycle.

The Anderson compression-condensation cycle seems to have thermo-dynamic possibilities that deserve serious attention because with saturated steam it is the Carnot cycle. It was a pity that Mr. Holcroft's article dealt mainly with the unsuccessful trials of the cycle on a locomotive, a most interesting tale which distracted attention from the cycle itself. The locomotive would seem to be the least suitable machine for using the cycle. The cycle shows theoretical efficiencies greater than those obtainable from a perfect bleed-feed heating regenerative steam cycle. It is, however, quite possible that the theoretical gain might be more than thrown away by practical losses. Unfortunately, the author has, so far, been able only to see *précis* of the McCallum-Anderson patents, and consequently does not know what the inventors claimed.

The cycle, as described by Mr. Holcroft, consists of condensing the exhaust incompletely, then compressing the residual steam-condensate mixture up to boiler pressure. Now there is no mystery as to what happens when a steam-water mixture is compressed. Roughly—roughly, if the mixture contains more than 50 per cent steam—evaporation of some of the water occurs; if the mixture contains more than 50 per cent water, condensation of some of the steam takes place on compression. In order that the compression-condensation cycle should have the best conditions, the amount of steam in the steam-condensate mixture entering the compressor must be equal to the quantity of steam that would be flashed off during the adiabatic expansion of water from boiler

temperature and pressure to the condenser pressure. Any less quantity of steam is simply loss to the cycle. Any greater quantity reduces the usefulness capacity of each pound of steam (decreases the volumetric efficiency), but does not theoretically damage the cycle efficiency. As the bald idea of recompressing exhaust steam to boiler pressure appears crazy, it merits a little discussion. If the whole of the exhaust steam from a perfect engine using saturated steam were recompressed to boiler pressure by a perfect compressor driven by the engine, the set would give no power and would work on an ordinary perpetual motion cycle. We can therefore say fairly categorically that exhaust steam recompression for power purposes is no good. (Instead of giving a Carnot rectangle on the temperature-entropy diagram, it gives a straight line !)

But the compression of low-pressure steam, so as to raise its temperature to enable it to transfer its latent heat, is another matter. Thermo-compressors for this purpose are in use in industry. The heat pump relies entirely on this process. Now, in the Anderson cycle this is what the compressor does. The compressor takes a large amount of condensate, containing only sensible heat, and a small amount of steam, containing sensible and latent heat. The condensate is pumped up to boiler pressure at constant low temperature. The steam, on the other hand, increases in temperature as its pressure is increased. It consequently transfers its latent heat to the condensate and appropriately condenses as its pressure rises. If the proportions of steam and water are well chosen, the high-pressure output of the compressor will be water only at the boiling temperature corresponding to the pressure. The whole secret of the cycle seems to be that the compressor is a device for making latent heat available, just as bleed heating is a method of using latent heat instead of rejecting it.

Fig. 1 is a temperature-entropy diagram showing a number of low-pressure, small heat drop cycles, from which a comparison is possible.

Cycle A

E A B C, Fig. 1

Steam at B, 160 lb per square inch gauge saturated, is expanded to a back pressure C of 10 lb per square inch gauge. The exhaust is totally condensed to E and the condensate is returned to the boiler and heated to A, then evaporated to B.

Heat input ... B−E = 1198 − 208 = 990 B.Th.U. per lb
Heat drop ... B−C = 1198 − 1051 = 147 ,,

$$\text{Cycle efficiency } \frac{147\times 100}{990} = 14\cdot 8 \text{ per cent}$$

Cycle B

H A B C, Fig. 1

Steam at B, 160 lb per square inch gauge saturated, is expanded to a back pressure C of 10 lb per square inch gauge, and exhausted to atmosphere. Cold feed at 60 deg. Fah. H is fed to the boiler.

Heat input ... B−H = 1198 − 28 = 1170 B.Th.U. per lb
Heat drop ... B−C = 1198 − 1051 = 147 ,,

$$\text{Cycle efficiency } \frac{147\times 100}{1170} = 12\cdot 6 \text{ per cent}$$

Cycle C

G A B C, Fig. 1

Exactly as in Cycle B, except that part of the exhaust is used for heating the feed from 60 deg. to 212 deg. Fah. (from H to G).

Heat input ... B−G = 1198 − 180 = 1018 B.Th.U. per lb
Heat drop ... B−C = 1198 − 1051 = 147 ,,

$$\text{Cycle efficiency } \frac{147\times 100}{1018} = 14\cdot 4 \text{ per cent}$$

Cycle D

D A B C, Fig. 1

Anderson compression-condensation cycle. Steam at B, 160 lb per square inch gauge saturated, is expanded to C, 10 lb per square inch gauge. The exhaust, at 10 lb per square inch, is partly condensed to D. The steam-condensate mixture is compressed to boiler pressure at A. (It will be seen that the cycle is a Carnot rectangle.)

Heat input ... B−A = 1198 − 344 = 854 B.Th.U. per lb
Heat drop ... B−C = 1198 − 1051 = 147 ,,
Energy for compression A−D = 344 − 332 = 12 ,,
Net power available = 147 − 12 = 135 ,,

$$\text{Cycle efficiency } \frac{135\times 100}{854} = 15\cdot 8 \text{ per cent}$$

Now Mr. Holcroft, in his locomotive experiments, was trying to substitute cycle D for cycle B. But in cycle B the exhaust energy at C at 10 lb. per square inch gauge is available for producing draught.

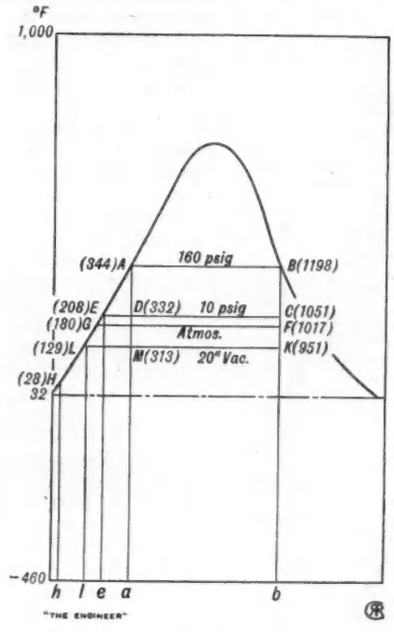


FIG. 1

The draught-producing heat drop is C−F = 1051 − 1017 = 34 B.Th.U. per lb.

Cycle D appeared to fall down due to draught difficulties. Therefore the theoretical efficiency of cycle D must, for comparison, be debited with a figure, say, 25 B.Th.U. per lb, for draught production.

Cycle E

This is Cycle D debited with 25 B.Th.U. for draught.

Heat input ... B−A = 1198 − 344 = 854 B.Th.U. per lb
Heat drop ... B−C = 1198 − 1051 = 147 ,,
Energy for compression A−D = 344 − 332 = 12 ,,
Energy for draught 25 ,,
Net power available 147 − 12 − 25 = 110 ,,

$$\text{Net cycle efficiency } \frac{110\times 100}{854} = 12\cdot 9 \text{ per cent}$$

Cycle B with exhaust to atmosphere with cold feed therefore appears very little worse

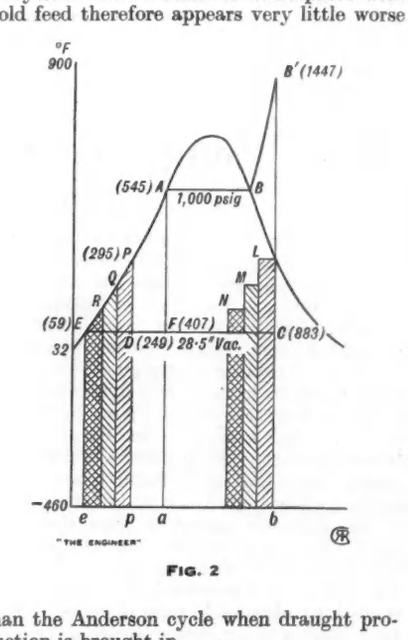


FIG. 2

than the Anderson cycle when draught production is brought in.

The foregoing seems to account satisfactorily for the disappointing results obtained on the locomotive trials. It is fairly clear that draught, or the lack of it, killed the Anderson cycle on the locomotive. It is therefore worth looking at the possibilities in plants where draught production is independent of engine exhaust.

Let us take a cycle applicable to a rather old-fashioned textile mill.

Cycle F

L A B K, Fig. 1

Steam at B, 160 lb per square inch gauge saturated, is expanded to K, 20in vacuum. The exhaust is completely condensed to L. The condensate is returned cool to the boiler and heated to A, then evaporated to B.

Heat input ... B−L = 1198 − 129 = 1069 B.Th.U. per lb
Heat drop ... B−K = 1198 − 951 = 247 ,,
There is no debit for draught.

$$\text{Cycle efficiency } \frac{247\times 100}{1069} = 23\cdot 2 \text{ per cent}$$

Cycle G

M A B K, Fig. 1

Anderson compression-condensation cycle. Steam at B, 160 lb per square inch gauge saturated, is expanded to K, 20in vacuum. The exhaust is partly condensed to M. The steam condensate mixture is compressed to A. Water at A is evaporated to B.

Heat input ... B−A = 1198 − 344 = 854 B.Th.U. per lb
Heat drop ... B−K = 1198 − 951 = 247 ,,
Energy for compression A−M = 344 − 313 = 31 ,,
Net power available 247 − 31 = 216 ,,

$$\text{Cycle efficiency } \frac{216\times 100}{854} = 25\cdot 3 \text{ per cent}$$

Compared with cycle F, the Anderson cycle shows an improvement of 2·1 on 23·2, or 9 per cent. This is well worth pursuing if the compressor is not too great a difficulty. Consideration of the θ/ϕ diagram suggests that the gain with bigger heat drops would be still more. Fig. 2 shows three cycles operating between 1000 lb per square inch gauge and 28·5in vacuum.

Cycle H

E A B B′ C, Fig. 2

Steam at B, 1000 lb per square inch gauge saturated, is superheated to 900 deg. Fah. at B′. The steam at B′ is expanded to C at 28·5in vacuum. The exhaust is completely condensed to E. The cool condensate is returned to the boiler and heated to A, then evaporated to B.

Heat input ... B′−E = 1447 − 59 = 1388 B.Th.U. per lb
Heat drop ... B′−C = 1447 − 883 = 564 ,,

$$\text{Cycle efficiency } \frac{564\times 100}{1388} = 40\cdot 6 \text{ per cent}$$

Cycle K

P A B B′ C, Fig. 2

As in cycle H, except that steam at L, M and N is bled off the turbine for feed heating to P, Q and R. The hot feed at P is pumped to the boiler and heated to A, and evaporated to B.

Heat input ... B′−P = 1447 − 295 = 1152 B.Th.U. per lb
Heat drop ... B′−C = 1447 − 883 = 564 ,,
Power forfeit by bleeds ... P−D 295 − 249 = 46 ,,
Net power available 564 − 46 = 518 ,,

$$\text{Cycle efficiency } \frac{518\times 100}{1152} = 44\cdot 9 \text{ per cent}$$

Cycle L

F A B B′ C, Fig. 2

Anderson compression-condensation cycle. Superheated steam at B′ is expanded to C. The exhaust is partly condensed to F. The steam-condensate mixture at F is compressed to boiler pressure at A.

Heat input ... B′−A = 1447 − 545 = 902 B.Th.U. per lb
Heat drop ... B′−C = 1447 − 883 = 564 ,,
Energy for compression A−F = 545 − 407 = 138 ,,
Net power available 564 − 138 = 426 ,,

$$\text{Cycle efficiency } \frac{426\times 100}{902} = 47\cdot 2 \text{ per cent}$$

The improvement by applying bleed heating to straight condensation is 4·3 on 40·6, or 10·6 per cent. The improvement by using the Anderson cycle instead of complete condensation is 6·6 on 40·6, or 16·2 per cent. The Anderson cycle is surely worth real thought. It may be that the Anderson efficiencies will be more difficult to achieve than the efficiencies of the regenerative bleed cycle. Bleed heaters are efficient pieces of simple stationary plant, though the bleeds slightly complicate the turbine performance, and feed heating may be a little uncertain on varying loads. A huge Anderson compressor is a formidable machine. It must be very multi-stage, and must start as a blower and end up as a centrifugal pump. The problem of securing the correct steam-condensate

mixture entering the compressor may be very hard to solve.

What about Mr. Holcroft's improvement of 31 per cent coal to kilowatts and 1 per cent of power output used for the compressor? Take conditions approximating those described by Mr. Holcroft.

Cycle M

H A B F, Fig. 1

Steam at B, 160 lb per square inch gauge saturated, is expanded to F at atmospheric pressure and exhausted to atmosphere. Cold feed at H is put into the boiler, heated to A and evaporated to B.

Heat input ... B − H = 1198 − 28 = 1170 B.Th.U. per lb
Heat drop ... B − F = 1198 − 1017 = 181 "

$$\text{Cycle efficiency } \frac{181 \times 100}{1170} = 15 \cdot 5 \text{ per cent}$$

The efficiency of cycle D, which is the corresponding Anderson cycle, was 15·8 per cent. This shows an improvement on the cycle only of 0·3 on 15·5, or 2 per cent. Allowing for prime mover efficiency ratio, boiler efficiency and compressor loss, it would seem unlikely that any improvement whatever would be gained except distilled boiler feed water.

In cycle D the heat drop was 147, and the theoretical compressor energy 12. The compressor therefore theoretically calls for 8 per cent of the power output.

These figures are so completely at variance with Mr. Holcroft's that some major consideration must have been omitted, either from the foregoing theory or from the practical test.

Recent Developments in Flying Boats*

By HENRY KNOWLER†

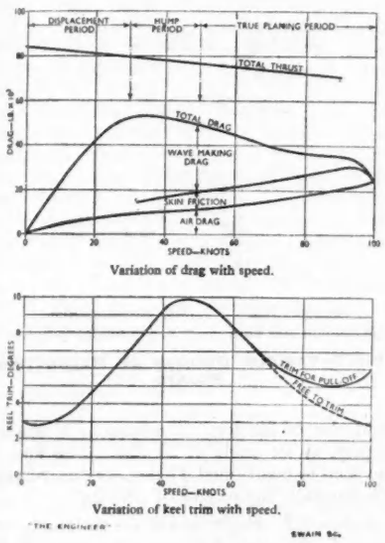
No. I

Introduction

IN this Lecture I shall confine my remarks to the design factors peculiar to flying boats, and, in general, I shall not discuss problems which are common to all aircraft, such as stability or control.

General Form

Before passing to more detailed discussion, it may be useful to outline the general con-



Variation of drag with speed.

Variation of keel trim with speed.

FIG. 1—EFFECT OF SPEED ON DRAG AND KEEL TRIM

siderations affecting the design. Since the hull is required to plane, it must be of chine form and have a step, which for balance reasons is placed a little aft of the centre of gravity. In all modern boats, fore-and-aft stability is obtained by the use of what is virtually a second step near the stern, although this is tapered to a point. The bows must strike a compromise between good water characteristics and low air drag. The wing must be set well clear of the water, so that the engines and propellers are free of heavy spray, and also to ensure that increased lift devices, such as wing flaps, do not get damaged when operating in heavy seas. Flying boats, therefore, are always of the high-wing type. The tail must also be set high for the same reason. Lateral stabilisation is usually obtained by the use of wing-tip floats. On some designs these are made to retract, but until recently this has not been popular. These considerations produce a general form rather distinct from land planes from which up till now there has been little variation.

Structure Weight

One of the major factors in aircraft design is the weight of the components. Contrary to general belief, the structure weight of flying boats is very similar to their contemporary landplane counterparts. Wing, tail units, and power installations have very comparable weights, but the hull of a flying boat —because it is required to operate on and from the water—has tended to be larger than a landplane of similar gross weight. Furthermore, it must be of far more robust construction; consequently, this component is always heavier than a fuselage. The lateral stabilising floats, on the other hand, are lighter than a landplane chassis, and this usually compensates for the excess weight of the hull.

Before leaving this aspect of the subject, I should like to draw the conclusion that increase in structure weight is not likely to be the limiting factor on the ultimate size of the flying boat.

Flying Boat Hull Air Drag.—The drag of a flying boat hull, due to its specialised form, is higher than that of the landplane fuselage, but in other respects the air resistance of the two types of machine is the same.

This discrepancy in drag due to body size has in the past been fairly large, due in great measure to the dimensions of the boat being dictated by buoyancy and propeller height considerations, rather than by the load to be carried. With the increased sizes of machine now in use, however, it is found that these dimensions are no longer sufficient to contain the greatly increased pay-loads which can be carried, and the body size is therefore defined by the same considerations which apply to the fuselage of the corresponding landplane, *i.e.*, pay-load capacity.

Hull Design

In the design of a flying boat hull form there are three requirements to be met, namely, low water resistance, stability throughout the take-off run, and clean running, or freedom from high-thrown spray. Perfection in all three requirements is seldom attained, as they tend to conflict; but a satisfactory compromise is obtained by model development tests in the seaplane testing tank. Before discussing hull lines, a general description of the behaviour of a flying boat on the water may be desirable.

The Take-Off.—The process of take-off and alighting of landplanes must be familiar to everyone, but the altered conditions due to marine operation are probably not so well known, and a description will assist in explaining some of the special features of a flying boat.

The take-off, from a design point of view, can be considered as consisting of three phases—displacement running, the hump period, and the true planing period (Fig. 1). The first, the displacement running period, starts with the opening of the engines and continues to about 30 per cent of the take-off speed. During this phase the machine runs practically as a displacement craft as there is little wing lift. The resistance steadily builds up as the machine accelerates, with increasing trim which is practically outside the pilot's control. During this part of the take-off, spray and solid water, called the "blister," is thrown off the chines, and under adverse conditions, may enter the propeller disc.

Fairly heavy turn-down of the chines at the bow will assist in deflecting the lighter spray, but has little effect on the blister (the latter being caused by the sudden release of pressure at the chine), which skims off the surface of the displacement wave and rises steeply, with considerable energy, and is sometimes the cause of trouble to the propellers, wing flaps and tailplane. The remedy in the latter case is to raise the propellers

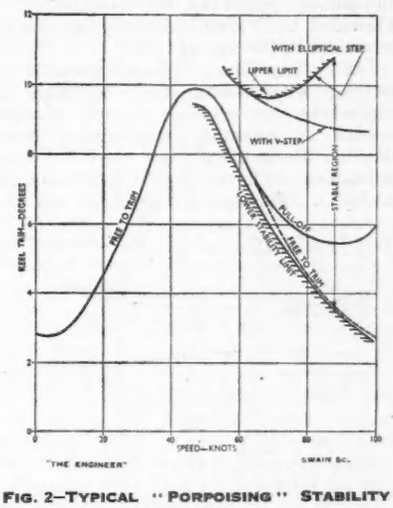


FIG. 2—TYPICAL "PORPOISING" STABILITY DIAGRAM

and wing well above the water. Modern large flying boats have a propeller water clearance of upwards of 6ft, but this must be increased with any rise in planing bottom loading. The bow spray may also cause trouble with the propellers, but this is of a much lighter nature, and is more capable of being turned down.

The next phase of take-off is the hump period, during which the machine passes into the true planing state. As the boat accelerates, the attitude on the water continues to rise to a peak value of 10-12 deg., after which it diminishes as true planing is established. (It is easy to understand why pilots named this point the "hump.") About the same time the water resistance increases to a peak, and then diminishes in phase with the attitude. The cause of the large attitude at the "hump" is the dynamic lift on the

* Institution of Mechanical Engineers. January 17th, Thomas Lowe Gray Lecture. Abstract.

† Chief designer, Messrs. Saunders-Roe, Ltd., East Cowes, Isle of Wight.

bottom forward of the centre of gravity and a suction on the aft bottom. The latter gradually clears after the " hump " speed is reached and the water then passes clear of the aft bottom.

In the last phase of take-off, the hull is truly planing with the wings gradually increasing their lift until flying speed is reached. The free running attitude gradually diminishes, and although the air drag now builds up, the water resistance is reduced until take-off. The fore-and-aft trim is now

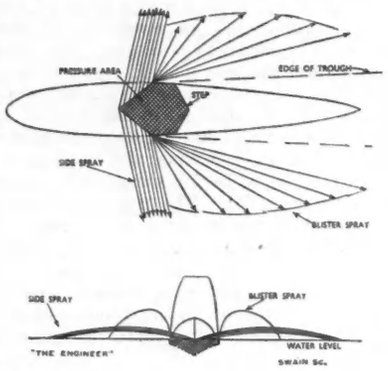


FIG. 3—DIAGRAM OF SPRAY FORMATION

more under the control of the pilot, who can choose, to some extent, the best angle to suit drag or stability conditions, but, particularly with highly loaded hulls, instability may arise, and, if serious, must be cured.

A great deal of theoretical investigation has been made into the causes and cure of fore-and-aft instability, or " porpoising " as it is called, but it is still necessary to check the behaviour in the testing tank.

The Testing Tank.—You are probably all familiar with testing tank technique as applied to ship models. A more involved method is necessary with flying boats. Wooden block models are used to obtain resistances, with varying displacements and attitudes. Fore-and-aft moments are also

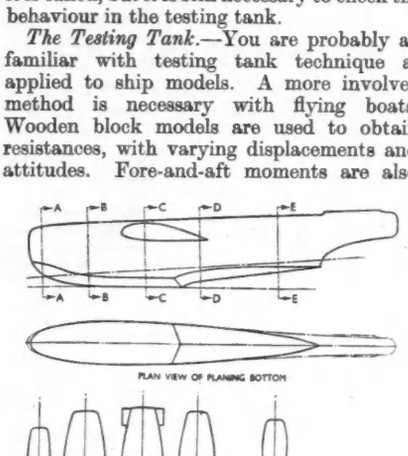


FIG. 4—OUTLINES AND CROSS-SECTIONS OF MODERN FLYING BOAT

measured. From an examination of the plots, a tendency to " porpoise " can usually be detected, and modifications are made to improve the characteristics. Finally, tests are made on a model of the whole machine, complete with propeller drives, &c. This model is made true to scale in weight and inertia, so that it is similar dynamically and leaves the water at the scale take-off speed.

Runs at constant speed are made with the model pitched by the elevator, or by shift of centre of gravity, to varying degrees of trim, and the inception of porpoising is recorded against attitude.

All model hulls porpoise at a fine and a coarse attitude (Fig. 2), known as the lower and upper limits of stability, the angle of pitch between these limits being called the stability range. When running under the design centre of gravity, and centralised elevator, a satisfactory machine should take up a " free to trim " attitude within this range.

Porpoising.—The tank technique just mentioned has been checked on a number of full-scale flying boats by much the same methods ; that is, constant speed runs with elevators held to a fixed position. The results show a quite satisfactory correspondence between model and the full-scale machine.

The reasons for porpoising and its avoidance are now becoming better known, due to careful analysis of model and full-scale behaviour. Generally, it can be said that porpoising is caused by interference on the afterbody of air and water flow from the forebody. In this interference air is " entrained " in the water and drawn away by a " pump " action, causing low pressures under the afterbody. The latter is sucked down, the pressure of water on the forebody increases, the hull lifts, breaks the suction on the afterbody and pitches forward, repeating the cycle as long as the favourable conditions continue.

The requirements of fore-and-aft trim in the displacement condition necessitate the use of an afterbody which is not required above the " hump " speed. The unstable tendency can sometimes be improved by lifting the afterbody keel line, by shift of the main step, prolonging the second step and by other methods, such as improved ventilation of the main step by deepening it or by lifting the chine on the afterbody.

A method is now being tested to eliminate the main step altogether by blowing air through the bottom in the step region. This method, by reason of its greatly improved ventilation, is found to give very satisfactory stability.

Spray Formation.—Knowledge on flying boat spray is still tentative, but the following conclusions are amply supported by experimental evidence. Spray formation above the hump speed is of little consequence to the machine, but at lower speeds it has great importance, as it may strike the propellers and wing structure. At these speeds it behaves as if it is mainly a displacement phenomenon.

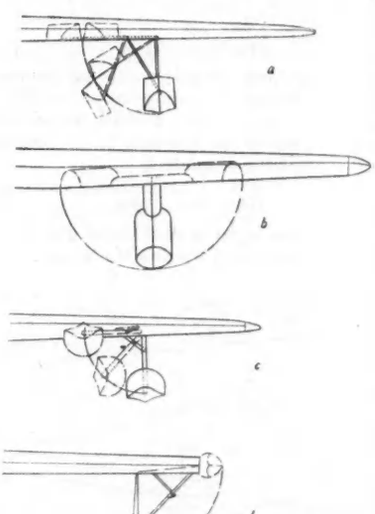
The spray includes a " blister " (Fig. 3) springing from the point where the forward edge of the area sustaining water pressure meets the chine. (This area is not identical with the area of wetted surface.) Under the " blister " is a wave, the surface of which detaches to form the " blister." Thus the latter depends on the displacement wave and is not mainly a planing phenomenon. A ribbon of water reflecting from the forward edge of the pressure area, called " side spray," is thrown out in the neighbourhood of the forward edge of the " blister." The angle at which this spray rises is controlled by the dead rise, although wind conditions can cause it to be thrown up and back across the " blister," with resultant interference and dirtiness. Unfortunately, increasing the flare at the bow chine does not turn the " blister " down, nor does decreased dead rise. The " side spray " is thrown out farther with low dead rise, but flare holds it low ; too much flare will direct it down so much that it reflects off the water surface.

The height of spray, as is well known, follows the laws of dynamic similarity, so that at the corresponding speed of $\sqrt{l}$ (l being the scale), the spray height varies directly with l. Hence it is possible to study model test behaviour in order to be able to predict the full-scale behaviour. The corresponding bottom pressures vary as the square of the velocity, *i.e.*, the spray heights are proportional to pressures. Generally, " side spray " is important in connection with the propeller height. The latter is usually capable of taking a large amount of light spray, but the machine's take-off weight may be limited by this factor. " Blister " spray, however, is heavy and is sometimes the cause of damage to the underwing surface and flaps. Wings are therefore set high to clear the " blister."

" Spray " and " blister " conditions are also present on the afterbody—the " blister " frequently being the cause of trouble to the tailplane, particularly during the landing run.

An example of the lines of a modern flying boat are shown in Fig. 4. These are for a machine with an all-up weight of 125,000 lb.

The main planing bottom is substantially parallel for about half its length forward from the main step, the cross section having a dead rise of 23 deg. with a gentle curve between the keel and the chine. The aft keel rises at an angle of 6½ deg. relative to the forward keel, the cross section aft having a



a, Saunders-Roe *c*, Saunders-Roe
b, Blohm and Voss *d*, Consolidated-Vultee

FIG. 5—VARIOUS DESIGNS OF RETRACTING FLOATS

dead rise of 32 deg. The step is V shaped in plan at an angle of 20 deg. The keel of the step is positioned 17 deg. to the vertical line through the centre of gravity.

Take-Off Performance.—Although, in general, the available space for take-off for flying boats is far less restricted than for landplanes, it is necessary to limit the run, both in time and distance. The limit in time under still air conditions is about 60 sec although about 40 sec is more usual. The distance permissible will vary with the base conditions, but if the length of water channel is limited, then the " unstick " run should not exceed half of the length available, so that in case of an engine failure occurring before a safe flying speed is reached, the machine can descend and alight without having to turn. A reasonable " unstick " run under no-wind conditions is about 1500 yards, but the distance is often extended to 2000 yards or more.

Take-off time and distance to " unstick " is capable of fairly accurate estimation from the results of tank tests and the performance of the aero-structure, together with the calculated thrust from the propellers. These calculations assume smooth water conditions,

but a rough sea may cause an increase in drag. It is necessary therefore always to have a reasonable acceleration at the point of minimum reserve thrust, *e.g.*, at the "hump." Acceleration here should not be less than about $0 \cdot 05\ g$.

Lateral Stability.—It will already be apparent to you that the hulls of flying boats alone are insufficiently stable laterally; they have, in fact, a large negative metacentric height. It is necessary therefore to restore stability by the addition of auxiliary flotation. There are two main methods of obtaining lateral stability on the water, namely, wing-tip floats and sponsons, the former being more generally used.

The upsetting moments which have to be met in calculating the wing float buoyancy are those due to (*a*) the weight moment (*b*) the lateral windage moment and (*c*) the propeller torque. Of these, the wind moment is by far the greatest, being four to five times the weight moment. Wind tunnel data are used in these calculations, and the moments are estimated for a specified lateral windage. In large machines of recent design a wind of 40 knots has been used. An additional allowance for reserve buoyancy is usually allowed of between 20 and 30 per cent.

The air drag of wing tip floats is not great when designed to a favourable shape, but several flying boats have been built with retracting floats. A patent taken out by my firm is shown in Fig. 5*a*. It will be seen that by splitting the float it has been possible to bury the whole structure in the wing section. Other methods which have been used are shown in Fig. 5*b*, *c* and *d*.

It may be remembered that the "Boeing" "Clipper" is stabilised by sponsons. It is generally contended that sponsons provide a more seaworthy machine, as there is little likelihood of their being smashed by waves, since they are well above solid water when the machine touches down on alighting, and only come into action as it slows up. There are, however, two rather serious disadvantages with this type of stabilisation, the first being their high air drag, due to size and shape, and the interference drag between themselves and the hull and the wing. The second disadvantage is their greater weight compared with wing-tip floats.

(To be continued)

Electrical Engineering in 1946

No. III—*(Continued from page 70, January 17th)*

Electric Traction

PLANNING rather than fulfilment was the keynote of railway electrification during 1946, after a seven-year interruption in normal development programmes in most parts of the world.

An important event, however, was the completion of the first 4¼ mile section (Liverpool Street–Stratford) of a project that was interrupted by the war: the eastern extension to the London Transport underground system. The extension now in service incorporates three new substations at Bethnal Green, Bow and Leytonstone. Each of these substations is equipped with G.E.C. pumpless rectifiers to supply 2000 kW at 630 volts—the first of nine 2000-kW, and thirteen 1500-kW units to be installed in this section of the London Transport system.

Towards the close of the year, the Southern Railway published details of important extensions to the companies' electrified system, together with the adoption of diesel electric traction for subsidiary services throughout South-East England (see THE ENGINEER, November 8, 1946). When this scheme is completed steam locomotives will ultimately be eliminated from the lines of the old L.B. and S.C. and S.E. and C. Railways. The new proposals will increase the 714 route miles already electrified by the conversion of a further 284 route miles on the main lines to the Kent coast and on secondary routes to Brighton. It is hoped that the work of conversion will be started in about four months' time on the boat-train routes and that the whole scheme will be completed by 1955, at an estimated cost of about £15,000,000. An interesting aspect of this project is that it will result in an annual saving of some 300,000 tons of coal over and above the 400,000 tons saved annually by the company's existing electrified system.

Coal is no less important to a country like Spain, where marked economy of operation and improved capacity and flexibility of service have resulted from railway electrification so far carried out. Further electrification of the Spanish State Railway is envisaged in a plan recently published by the Ministry of Public Works. This plan (see THE ENGINEER, November 22, 1946) should improve the railway services and should also benefit the general economy of a country whose coal production, consisting mainly of anthracite, is meagre.

The plan envisages the construction of a number of new pithead power stations which, in conjunction with the existing stations operating on anthracite, will generate about 855 million kWh per annum. Important hydro-electric stations which will be finished in 1955 will produce about 5642 kWh per annum. With the electrification of about 4500 km of track it is hoped that the scheme will be completed in 1958, and will result in an annual saving of more than a million tons of locomotive coal. This quantity of coal, burnt in efficient steam generating stations would provide 1480 kWh per annum, or more than double the total energy required for the development of the electrification plan.

In Brazil, the Sao Paulo Railway is to electrify the line from Sao Paulo to Jundiahy. The comprehensive contract for the electrification of this line at 3000 volts d.c. has been placed with English Electric Company, Ltd., who will supply the main line locomotives together with substation and overhead line equipment.

Trolleybus services have provided British manufacturers with large orders and with the opportunities for introducing a number of improvements, including a new design of motor, which is constructed to be floodproof, and will operate satisfactorily in water reaching up to the shaft centre line.

Sixty-five trolleybuses for Cardiff City Transport Department are being equipped by the G.E.C., Ltd., with floodproof compound motors designed for a limited regenerative characteristic associated with rheostatic braking—a system that has the advantage of avoiding the high voltage troubles usually associated with any appreciable regeneration of energy to the line. The same company is supplying the Belfast City Transport Department with 24 regenerative trolleybus equipments, similar to the 88 equipments completed at the outbreak of war. Another 70 equipments ordered by the same customer will be of the non-regenerative design.

Floodproof motors are being incorporated by B.T.-H., Ltd., in all new trolleybus orders, including 52 equipments for Wolverhampton, 15 for Derby and 12 for Mexborough. This firm is carrying out tests on a new form of relay-operated control which will enable the maximum acceleration of a trolleybus to be attained automatically.

Radio Navigation

An event of outstanding importance to radio engineers was the Radiolocation Convention held from March 26th to 29th at the Institution of Electrical Engineers, London. The Convention provided a welcome opportunity for the discussion in a series of papers and lectures of various aspects of radiolocation that could not be made public until the end of hostilities. For the first time the magnitude and detail of a unique technical achievement, shared jointly by Great Britain and the U.S.A., was revealed in full.

It is encouraging to find that the enthusiasm and energy which made radiolocation into a war-winning weapon are being diverted immediately into peacetime channels where both marine and air navigation stand to benefit substantially from applications of radar technique. Radar aids to air navigation include a number of systems, most of which are adaptations of the highly successful military devices. The very variety of available methods is, however, indirectly embarrassing, for the international links between modern air lines demand that an early choice shall be made with a view to adopting the most suitable systems as standard and eliminating the remainder.

Matters of this sort are the immediate concern of the radio technical division of "Picao" (Provisional International Civil Aviation Organisation). More than twenty-eight countries were represented when this division of Picao met last October in Montreal to discuss standardisation of flying aids. It will be remembered that this meeting was preceded in September by a demonstration of British navigational aids which were seen in action by Picao delegates. At the Montreal meeting an agreement was reached which will bring world-wide standardisation within sight. Full details have not yet been published, and in any event the Montreal recommendations must first be approved by the Picao Interim Council and by the Governments concerned. It can be said, however, that the recommendations represent a compromise between the best of the British radar devices and of the American-sponsored radio aids to navigation.

In marine circles considerable interest was aroused by a demonstration in H.M.S. "Fleetwood" of radio and radar aids to navigation. During the course of a four-hour sea trip in April last, D/F systems, using Orfordness Beacon, were shown in operation; Decca, Gee and Consol were demonstrated, and a thirty-minute "blind" run was made under the control of shipborne radar.

Two of the firms engaged in the development and manufacture of radar equipment for marine navigation—Marconi, Ltd., and Metropolitan-Vickers Electrical Company, Ltd.—gave demonstrations of their apparatus in the summer of 1946. The Marconi radar equipment, shown in its prototype form, consisted of two units. The upper unit contained

the whole of the high-frequency circuits, together with the aerial system; the lower unit contained the P.P.I. display. In the M-V radar set the transmitter and rotating aerial were arranged in separate units, while the remaining apparatus, including controls and P.P.I. display, were housed in a console. Recent installations of M-V marine radar include those fitted during the year in mv. "Crane," ss. "Kronprins Frederik," and ss. "Manchester Shipper."

Another device that should be of considerable interest to mariners is the Decca navigator, which is a simple radio system designed to give accurate and continuous data for position fixing. In THE ENGINEER, May 10, 1946, our account of the demonstration in H.M.S. "Fleetwood" included a brief reference to the Decca system, which employs a multi-channel shipborne radio receiver used in conjunction with a chain of shore-based transmitting stations to give a very rapid and accurate position fix. Trials extending over a period of six months have since been carried out with Decca receivers fitted in thirty-five merchant ships carrying out their normal runs in the North Sea, English Channel and Irish Sea. As a result, the Ministry of Transport has advised the Decca Navigator Company that, subject to certain conditions, the Decca system is approved for the purposes of general marine navigation, excluding pilotage, in specified areas. At the time of writing, the Admiralty is about to issue a notice to mariners whereby all shipping companies and masters will be advised of the areas in which the system may be applied and the method to be used.

Application of any system, such as the Decca navigator, naturally depends upon the area effectively covered by the chains of transmitting stations. The English chain, which is already in operation, extends up to 275 statute miles from London, and the company has given close attention during the past year to the wider problems of obtaining world coverage. Plans for the erection of Decca chains in certain foreign territories have been submitted to the Governments concerned. In particular, a scheme for Iceland is being considered by the Icelandic Government; a New York chain has already been sited, and an application for allocation of the required radio frequencies is being submitted in Washington. In parallel with their long-term plans for wider application of the system, the Decca Navigator Company is now engaged in the production of a new marine receiver, which is immediately available on a hire and maintenance basis to shipping companies using the English chain of stations. This receiver, which embodies the extensive experience gained in sea-going trials is claimed to be completely waterproof and capable of withstanding extreme weather conditions.

(*To be continued*)

Shipbuilding and Marine Engineering in 1946

No. IV—(*Continued from page 71, January 17th*)

Boiler Engineering

BABCOCK and Wilcox, Ltd., of London and Renfrew, reports that at the end of 1946 boilers were in hand for about ninety ships for installation in passenger liners, cargo ships, tankers, Cross-Channel ships and smaller vessels. During the year the Renfrew works was changed over from wartime to peacetime production, and the only naval work remaining was the completion of two sets of boilers for H.M. "Daring" class destroyers, which will operate at a pressure of 650 lb per square inch and a final temperature of 850 deg. Fah. with controlled superheat. Among the larger ships are boiler installations for the two Union-Castle liners "Edinburgh Castle" and "Pretoria Castle," now under construction at Harland and Wolff's Belfast yards. These boilers are to be designed for a working pressure of 650 lb per square inch and 850 deg. Fah. final temperature. They will be the double-furnace, controlled-superheat design, fitted with stud-tube economisers and Howden Ljungström air preheaters. The bulk of the remaining boilers will be of the 450 lb per square inch pressure and 750 deg. Fah. final temperature design. In all cases Babcock fusion-welded drums and high-pressure parts will be incorporated.

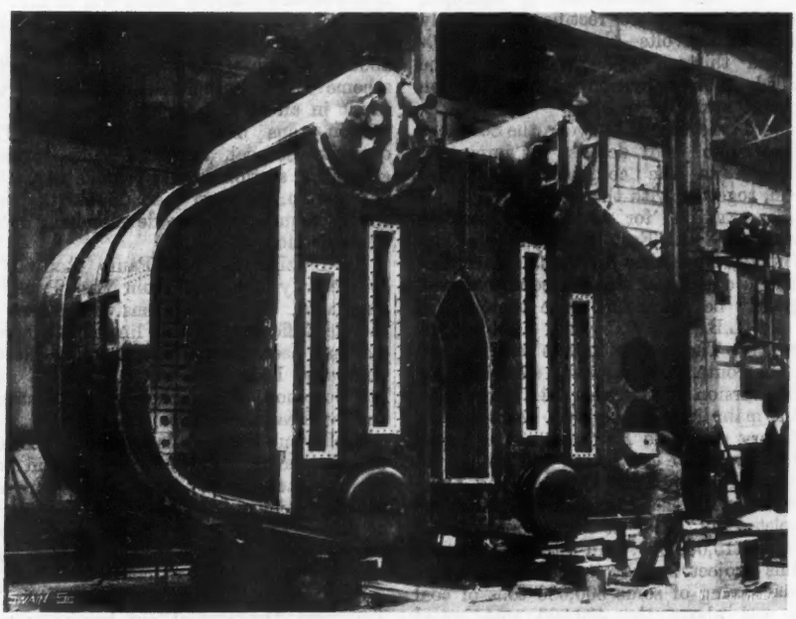
Orders for cargo liners include boilers for ships for the Ellerman group, Liverpool, Clan Line Steamers, Ltd., Ben Line Steamers, Ltd., the Anglo-Saxon Petroleum Company, Elders and Fyffes, Ltd., the Isle of Man Steam Packet Company, the Great Western Railway Company, and the British India Steam Navigation Company, Ltd. Of special interest are the four boilers for the Blue Star Line ships to be built by Cammell, Laird and Co., Ltd., which will be equipped with automatic combustion control. In the course of the year several high-output wide-range oil burners were installed in ships. Several whale-catcher boilers are to be installed in catchers built by Smith's Dock Company, Ltd. These boilers are similar in design to those of the "Southern Wilcox," which saw service in the Antarctic during 1946.

For ships built in Australia for the Broken Hill Proprietary Company, Ltd., Babcock-Erith mechanical stokers were fitted, and this same stoker was also installed in other Australian-built vessels.

During 1946 orders were placed for a large number of Foster-Wheeler water-tube boilers for important naval and mercantile ships, the boilers being built by shipbuilders and marine engineers under licence. Naval boilers of this design include those for the "Daring" class H.M. destroyers, designed to work at a pressure of 650 lb per square inch and 850 deg. Fah. final temperature. These boilers will be of the controlled superheat type. The same type of boiler will be installed in new vessels under construction for the Orient Line, the P. & O. Line, and cargo liners for the Royal Mail Lines, Ltd., the P. & O., Shaw, Savill and Albion Company, Ltd., Alfred Holt and Co., and the Cunard White Star, Ltd.

Foster-Wheeler boilers are also being built for 8000 h.p. engined cargo liners, using 450 lb per square inch working pressure and 750 deg. Fah. final temperature. These include vessels for the Silver Line, Ltd., the Moller Line and the New Zealand Shipping Company, Ltd.

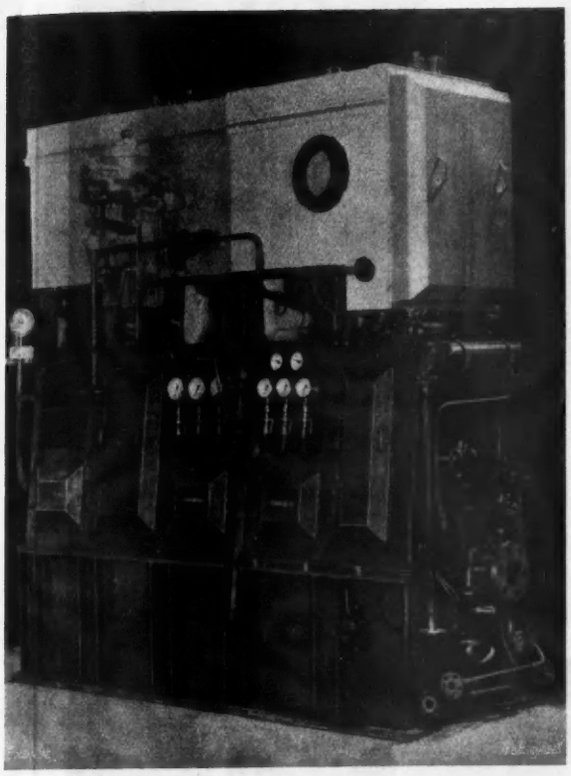
Richardsons, Westgarth and Co., Ltd., has several orders on hand for Foster-Wheeler water-tube boilers for whale catchers for British and Norwegian owners, which are under construction at Smith's Dock Company, Ltd. They are similar in design to the pair of boilers constructed for the "Southern Whaler," which was built for Chr. Salvesen and Co., and during the year was in the Antarctic. The accompanying engraving shows the latter boiler, which has a designed output of 17,500 lb of steam per hour, or a total of 35,000 lb for the pair of boilers. The boiler produced saturated steam at 225 lb per square inch working pressure. Foster-Wheeler boilers are also to be fitted in some Cross-Channel steamers, one of which is the Southern Railway Company's steamer "Falaise," under



PAIR OF WHALE CATCHER BOILERS

construction in the Dumbarton yard of William Denny and Brothers, Ltd.

A large number of post-war merchant vessels, both passenger liners and cargo liners, are being equipped with water-tube boilers, built to designs supplied by Yarrow and Co., Ltd., the boilers themselves being built under licence by the shipbuilding firms. This boiler programme includes water-tube boilers for ships now being built or on order at other shipbuilding yards for Cunard White Star, Ltd., the Union Steam Ship Company, of New Zealand, the Shaw, Savill and Albion Company, Ltd., Furness, Withy and Co., Ltd., the London and North-Eastern Railway Company, the Bibby Line, Ltd., and the Donaldson Line, Ltd.



LOBNITZ PRESSURE-LUBRICATED STEAM ENGINE

MARINE ENGINEERING

During the year, several Lobnitz pressure-lubricated steam reciprocating engines were built for merchant vessels. This new type of prime mover was developed during the war, and was installed in fourteen naval minesweepers, in which good results were obtained in severe operating conditions. The engine is a multi-expansion, totally-enclosed pressure-lubricated unit of welded design.

A range of sixteen three-cylinder engines, having designed outputs from 152 i.h.p. at 372 r.p.m. to 3200 i.h.p. at 202 r.p.m., and a similar number of four-cylinder engines, ranging from 184 i.h.p. at 475 r.p.m. to 3900 i.h.p. at 257 r.p.m., has been designed. We illustrate a typical three-cylinder unit, having a maximum output of 507 i.h.p. at 300 r.p.m. The bedplate is a welded steel fabricated structure, which can be designed either for wet or dry sump lubrication. The forged steel crankshaft is assembled by shrinking journals into one-piece units, each comprising a crankpin and crank webs of the balanced type. The entablature is also a welded fabricated structure, with large doors giving easy access to all working parts. The cylinders, which have straight ports, are the only major iron castings, and they are so mounted as to avoid expansion differences. A piston valve is fitted in the h.p. casing and balanced slide valves in the other casings. A direct-acting reversing engine operated from the starting platform controls Stephenson link motion gear. The forged steel piston rod and the valve rod are fitted with a steam packing and oil-retaining packing, which are arranged so that no part of the rods works in both metallic packings. Contamination of the lubricating oil by water is thereby eliminated. The lubricating oil pump is driven from the crankshaft and it supplies oil under pressure to every part of the engine. In the lubricating oil circuit there is a fine mesh filter and oil cooler. The capacity of the engine oil distribution main and the pump has been so chosen that an adequate supply of oil is delivered to the bearings under every manœuvring condition. If desired, a centrifugal purifier can be fitted, which takes off a continuous supply of lubricating oil and cleans it in the circuit. Trial results of the Lobnitz engine have shown that the new design described surpasses the open type of steam reciprocating engine. Using steam at 250 lb per square inch, either saturated or superheated, the steam consumption is comparable with standard steam reciprocating engine practice, and service reports give a low consumption of lubricating oil.

L.M.S. "Patriot" Conversions

WHEN dealing with the work of the London, Midland and Scottish Railway Company in the annual review of steam locomotives in our issue of January 3, 1947, we mentioned that two of the "Patriot" class three-cylinder, 5X, 4–6–0 locomotives had been converted to class "6" express passenger engines. Further particulars of this conversion work have now been received from the L.M.S., and a photograph of one of the rebuilt engines is reproduced in the accompanying engraving.

The "Patriot" engines fitted with parallel boilers and having the power classification 5X were originally classified as rebuilds of the four-cylinder "Sir Gilbert Claughton" class of the former L.N.W.R. In all, fifty-two of these engines were completed during the years 1930–1934, to the designs of the late Sir Henry Fowler.

A comparison of the leading particulars both before and after rebuilding is given below :—

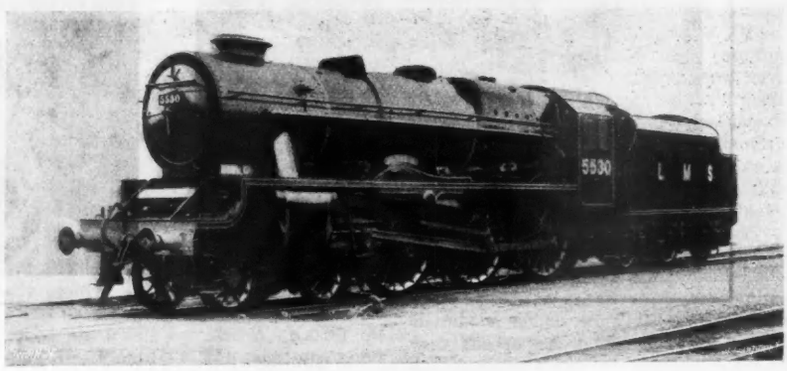
	As built in 1930–34.	As rebuilt.
Driving wheels, diameter ...	6ft 9in	6ft 9in
Cylinders :		
Number ...	Three	Three
Diameter ...	18in	17in
Stroke... ...	26in	26in
Boiler pressure	200 lb per sq in	250 lb per sq in
Tractive effort at 85 per cent b.p.	26,520 lb	29,590 lb
Heating surface :		
Firebox ...	183 sq ft	195 sq ft
Tubes... ...	1552 sq ft	1667 sq ft
Total evaporative ...	1735 sq ft	1862 sq ft
Superheater..	365 sq ft	348 sq ft
Grate area ...	30·5 sq ft	31·25 sq ft
Weight in working order :		
Engine ...	80 tons 15 cwt	82 tons
Tender ...	42 tons 14 cwt	53 tons 13 cwt
Total	123 tons 9 cwt	135 tons 13 cwt

Several of the engines are now falling due for new boilers and are being rebuilt to the designs of the chief mechanical engineer, Mr. H. G. Ivatt, to take the type "2A" taper boiler, which has been used successfully on the "Royal Scot" conversions as well as on two of the "Silver Jubilee" class engines. This policy is also dictated by traffic requirements, in so far as the reboilering raises the engines from power classification 5X to Class "6." The conversion of eighteen of the "Patriot" class engines has been authorised in the first instance, and it is intended that the work shall be completed during 1947.

The opportunity has been taken to renew various details, such as the cab, smokebox and saddle, cylinders and the spring suspension, so that the converted engine becomes virtually identical with the two converted "Silver Jubilee" engines. It is interesting to note that the whole conversion has been carried out with an increase in weight of the engine portion of only 1 ton 5 cwt, whilst the tractive effort at 85 per cent boiler pressure has increased from 26,520 lb to 29,590 lb.

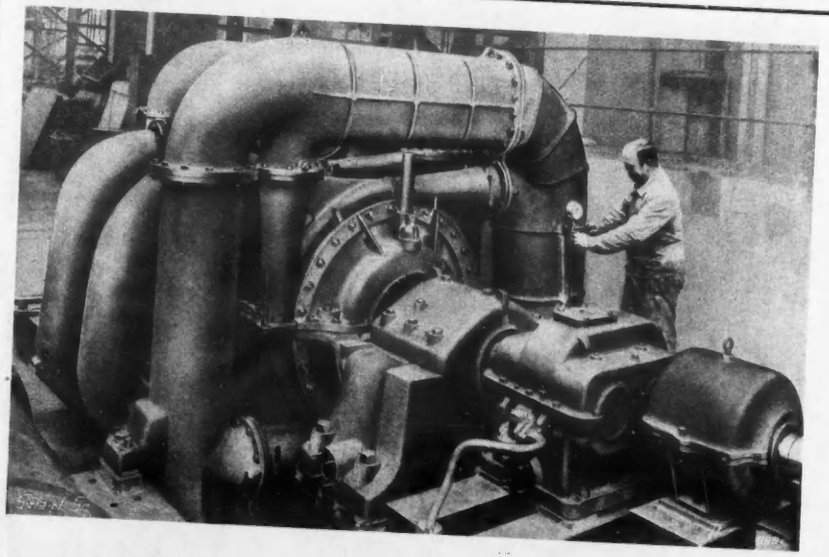
In accordance with the policy of the company, the rebuilt engines are being provided with rocking grates, self-emptying ashpans and self-cleaning smokeboxes. Tenders of the standard 4000-gallon type are being provided in place of the earlier pattern of 3500 gallons capacity.

It will be seen that by the modifications now being carried out these powerful engines, which have rendered from twelve to sixteen years of valuable service, but which were becoming obsolete in relation to more recent designs, are being thoroughly modernised and made suitable for a further period of usefulness.

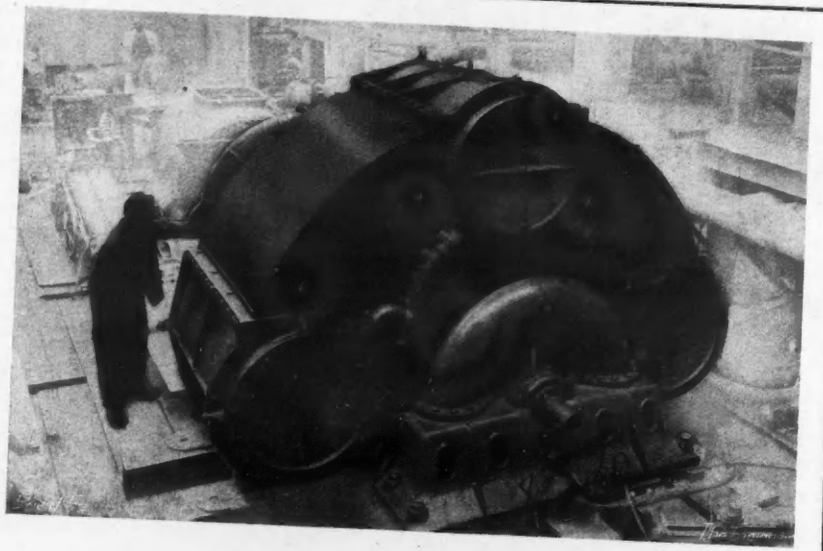


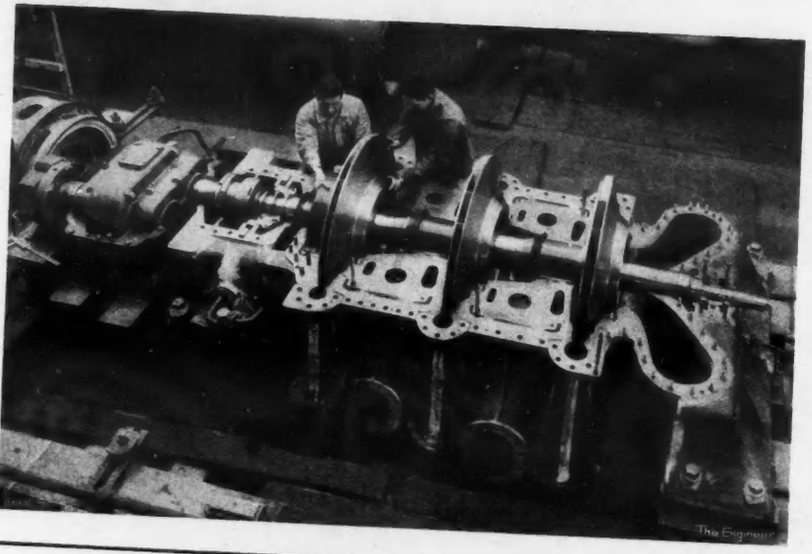
CONVERTED L.M.S. "PATRIOT" CLASS LOCOMOTIVE

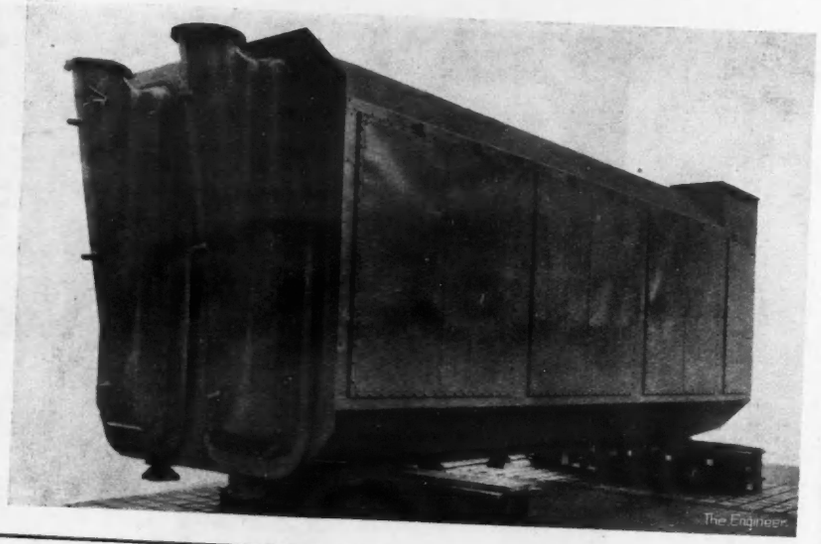
GAS TURBINE DEVELOPMENT IN SWITZERLAND



EARLY COMPRESSOR WITHOUT INTERCOOLER AIR COMPRESSOR ROTOR







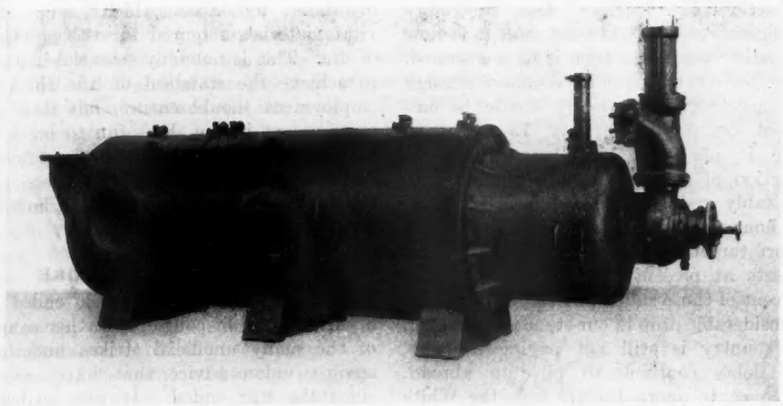
THREE-STAGE AIR COMPRESSOR WITH INTERCOOLERS RECUPERATOR

Gas Turbine Development in 1946

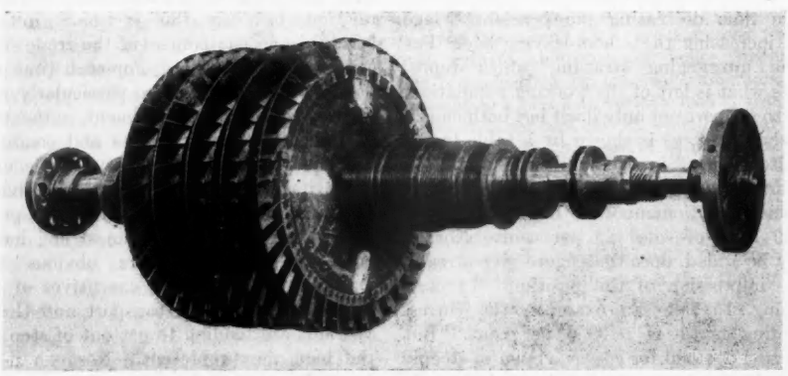
No. IV—*(Continued from page 79, January 17th)*

ATELIERS DE CONSTRUCTION OERLIKON, ZÜRICH-OERLIKON, SWITZERLAND

IN our last article we gave a short description of the 1000-kW experimental gas turbine unit, which during 1946 was put to work in the Oerlikon factory at Zürich-Oerlikon, Switzerland. One of the more important parts of this plant is the air compressor, which has been developed on new and interesting lines. It is of the radial type and the casing of each stage is divided into four partial spirals, to which four diffusers are connected. The transformation of velocity into pressure takes place favourably in the straight diffusers, giving a high efficiency. In the two upper views opposite we show to the left an exterior view of an earlier construction of this new compressor without interstage cooling. The arrangement of the spirals and diffusers will be clearly seen. In the right-hand upper view the three-stage air compressor with its intercoolers is shown.



COMBUSTION CHAMBER



ROTOR OF GAS TURBINE

The construction of this radial compressor is novel in the design and arrangement of the intercoolers. They are arranged around the casing of the air compressor at equal angles of 90 deg. and our engraving shows three of the four parallel coolers. Each of the four intercoolers is made in two halves, one of which is connected between the first and the second stages of compression and the other between the second and third stages of compression. The compressor is designed for a working pressure of 4 atmospheres. In the left-hand lower view an illustration of the rotor of the air compressor is given, and on the right-hand side the recuperator is shown. Other views reproduced herewith show the combustion chamber and the rotor and shaft of one of the two gas turbines. The design of all these parts has been based on the results of the firm's own research work.

It is expected that results of the experimental tests made with this plant will be published by the Oerlikon Company at a later date. The company, however, states its belief that, under similar conditions, the performance of the Oerlikon gas turbine will be at least equal to the performance of other gas turbine plants described in contemporary technical literature. Such turbines, it holds, will open up a great field of new applications, especially in the sphere of heat power plants.

In the year under review the Oerlikon Company has specially studied the introduction of the gas turbine into heat power stations. Its view is that in a similar manner to the back-pressure steam turbine the gas turbine may be used to produce power at high efficiencies if it is introduced into the heat circuit of a furnace, such as the steam boiler of works or factory plant.

In our issue of December 13, 1946, we published an article by Mr. W. Karrer on "Steam-Air Plants." The accompanying diagram shows clearly the arrangement of one of the different possible circuits of such a plant. Another combined circuit of the kind is the steam-gas plant, which has been designed and worked upon in the Oerlikon research laboratory and, like the steam-air plant, is the subject of patents. From the first view it will be seen that the air produced by the compressor is heated in the heat exchanger by the combustion gases of the steam boiler, and the gas turbine will therefore be an air turbine. In the second view the compressed air is heated in the combustion chamber of the gas turbine plant by the direct introduction of oil fuel. In this case, therefore, the gas turbine is driven by the combustion gases. As, however, the surplus of air in a gas turbine plant is very high, nothing prevents the waste gases being used as combustion air in the steam boiler, this arrangement having been adopted with success in the boiler in the Oerlikon works. In both the circuits illustrated a means is provided for increasing considerably the power output of a back-pressure steam plant. The advantage of the steam-air plant is the burning of solid fuel for both the steam and the air turbine sides, while in the steam-gas plant circuit there is a gain in simplicity, especially in the alterations necessary when adapting such a scheme to existing boiler plants. Two outstanding advantages of both circuits, it is pointed out, are, first, that the power of the air or gas turbine is generated without the need of water; and secondly, that, compared with a steam turbine, the air and gas turbines can be started up much more quickly.

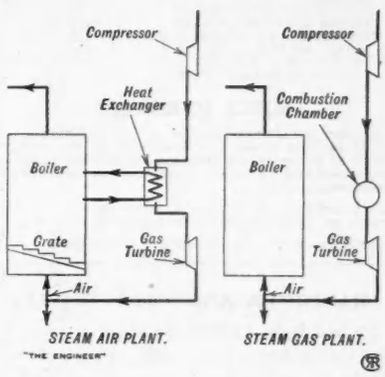


DIAGRAM OF STEAM-AIR AND STEAM-GAS CIRCUITS

GERMAN GAS TURBINE PLANTS FOR TRACTION

In a paper presented for written discussion to the Institution of Mechanical Engineers on November 30, 1946, Lieut.-Colonel R. H. Bright, R.T.R., Chairman of the Automotive Group, Combined Intelligence Objectives Sub-Committee, the Ministry of Supply, described and illustrated several arrangements considered by the German firms in the later stages of the war, for using fuels of low quality and of increasing considerably the power-to-weight and power-to-volume ratios of the power unit in a traction plant. Various arrangements using either one single gas turbine or separate turbines to drive the compressor and provide useful output are shown. The details of components, such as air compressors, gas turbines and combustion chambers, which are given in the drawings with the paper should be very useful for development work.

(To be continued)

THE ENGINEER

JANUARY 24, 1947

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MANPOWER AND PRODUCTIVITY

IT has been known for some weeks that the Government had under preparation a White Paper on the "Economic Considerations Affecting Relations Between Employers and Workers." But the expectation that it would prove to be a momentous document was sadly disappointed when publication occurred last Tuesday. For this White Paper adds little or nothing to what was already known about the economic position of this country. It has to be remembered, however, that it was prepared by the Government and approved by the National Joint Advisory Council, and is, therefore, an agreed statement by the Government, the British Employers' Confederation, and the Trades Union Congress. If it does little to show what positive actions, if any, can be taken, apart from raising productivity, to improve the situation, it does reveal that all three parties are agreed upon the facts, and by bringing all those relevant facts together in an easily digestible form it does serve to emphasise how serious the situation really is.

The document shows that as compared with mid-1939 the numbers of workers in productive industry, both for home supply and exports, had increased by November, 1946, from 14,310,000 to 14,628,000. At first sight such figures, which apply only to those productively employed, seem not so very unsatisfactory, more particularly since the entry into industry of further workers demobilised from the armed forces can still be expected. But that latter increment, it should be remembered, is likely to be offset by the effect of raising the school-leaving age this year to fifteen, whilst in subsequent years the result of the low birth-rate in the "thirties" will be felt in a reduction of the number of those entering industry to replace wastage. Moreover, the figures must be considered in relation to the ruling conditions. The reasons why our export trade must be increased in volume by 75 per cent above the pre-war level are by now only too well understood by everyone. Before the war, just under 1,000,000 workers were employed on production for export. Last November the figure reached 1,440,000, and it is now estimated that if the target is to be attained, a further 500,000 will be required (though why nearly twice as many should be employed on producing only 75 per cent more is not made wholly clear). The diversion of so many to the export trade inevitably reduces the numbers available for home production. But to reach the export target seems essential. For though imports at present are running at only 70 per cent of those ruling in 1939, representing a considerable drop in our standard of living, the country is still not paying its way, and debts continue to pile up abroad. Moreover, to quote directly from the White Paper, "The country has six years' arrears of civilian work to catch up in addition to repairing a vast amount of bomb-damage and rebuilding blitzed areas. New houses have to be built; industry has to be modernised and re-equipped with new factories and plant; the public services have to be brought up to a proper standard of efficiency," and so on, requiring yet a further diversion of workers from the production of consumer goods. Further, the grant to the people of this country of "social security" necessarily leads to increased demand. We are, as the chairman of the National Bank expressed it some days ago, burning the candle at both ends by at one and the same time decreasing the pensionable age and increasing the school-leaving age. For "the intervening stratum, which represents what is left of the working population, has to support not only itself but both ends." In the result, as is shown by a table in the White Paper, in a number of selected "vital" industries, there is a percentage deficiency of manpower below the mid-1939 level of some 22 per cent. Nor, it may be added, does that figure give a really true impression of the position. In coal-mining, to take an example, the corresponding figure is only 6 per cent. But internal demand for coal has risen so steeply that if the home market is to be amply supplied and our old export position is to be recaptured and no increase of productivity per man hour was to occur in the interim, a much greater increase than 6 per cent in the numbers employed would be necessary. The answer to such deficiencies is, of course, increased productivity. To quote from the White Paper, "The answer first and last is by increasing production. This is the only means by which we can achieve a genuine and permanent balance between the volume of purchasing power and the supply of goods available."

The weakness of the document—a weakness that possibly reveals a lack of agreement amongst the members of the National Joint Advisory Council that approved it—is that while pointing out very clearly and simply the actual facts, it suggests no positive means by which higher productivity is to be achieved. The mal-distribution of workers amongst the various industries that is the cause of certain shortages hampering output is, indeed, stressed. "Some of the most vital industries are more severely under-manned than industry as a whole." But no suggestion is offered as to how that mal-distribution can be cured. We are merely told "We must concentrate on increasing production in these industries which supply the vital materials required for the necessities of life. This is not only essential if we are to achieve the standard of life which full employment should ensure, but it is now more urgent in the short run to break the shortage of basic materials which are holding up the whole process of reconversion of civilian life and industry." But how is it to be done?

THE TRANSPORT STRIKE

THE transport strike which ended last Saturday was, of course, a further example of the many unofficial strikes undertaken against union advice that have occurred since the war ended. It was settled by the hasty creation of a new negotiating body which, incidentally, proved unable to reach agreement upon the men's claims so that a court of enquiry has since had to be set up. But the affair is far from ending with the end of the strike. Nor will even the eventual settlement of the points in dispute conclude it. For partly because it affected the distribution of London's food and partly because it was supported by equally unofficial sympathetic action in other quarters, the strike served to raise and to emphasise the importance of issues that have been for some time implicit in the labour situation.

The more obvious of the issues raised is that of the effect of such strikes upon the relation between the sectional interests involved and the policies of the trade unions concerned as a whole. For each time such a strike occurs, and more particularly when it results in an improvement, satisfactory to those involved, in wages and conditions of employment the authority of the union is inevitably weakened and other individual sections are encouraged similarly to pursue their own advantage. The strike, indeed, made it all the more obvious than it was before that the executives of such large unions as the Transport and General Workers are tending to get out of step with the men they represent. Nor can it any longer be contended, we fear, that the matter is one for the unions alone to settle by some such means as the improvement of the representation of sectional interests on the central executive. For the threat is implicit in these repeated unofficial strikes that the whole machinery of negotiation as between employers and employed, built up with tribulation and by conflict in the past and intended to prevent just such a stoppage as has occurred, may break down owing to the inability of the unions to carry the confidence of the men they represent and whom they commit when reaching agreements with employers. Trade union

leaders, no doubt, are well aware that greater prosperity and a higher standard of living can only be enjoyed as a consequence of greater productivity. They cannot be blind to the fact that increased wages and shorter hours of work cannot of themselves create higher standards and may, indeed, by their adverse effect upon prices and the consequent difficulty of maintaining exports in the face of world competition, debase them. They know that since the outbreak of the recent war a change, almost revolutionary in character, has occurred in economic thought, largely as a result of the teachings of the late Lord Keynes; and that actions that might well be justifiable in a world wracked by depressions and unemployment become unreasonable when there is a shortage both of labour and of the products of labour. But these facts are still not understood, apparently, by the men; and it is, indeed, doubtful whether the unions, which are so eager to impose their views on the Government, have made much serious effort to explain them to the men. Is it not, therefore, natural that the latter should continue to follow, sectionally, that path which, in the past, and under very different circumstances, won for them improved conditions and standards of life?

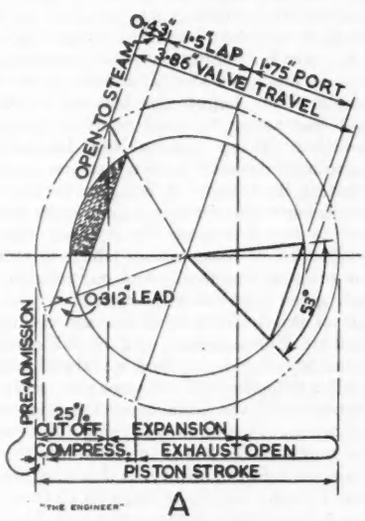
The issue of discipline within the unions is itself an important one. But another as great of moment is raised by the strike. It is well known that the present shortage of labour has led in particular to special difficulties in certain trades, notably coal-mining and founding, which are proving unattractive. It is that fact, amongst others, that has led to proposals for a "national" wages policy. For it is contended that in the absence of direction of labour, a power being given up by the Government, the only method by which to secure a satisfactory distribution of the labour force amongst trades of differing popularity would be by the use of wage differentials. No body other than the Government, in consultation with the T.U.C., could possibly have the full detailed knowledge necessary to determine what differentials were desirable. In the past we have opposed a national wages policy partly because no satisfactorily complete definition as to what is meant by such a policy has ever been authoritatively offered and more particularly because we doubt its practicability. The recent strike tends to confirm us in that latter opinion. The unions themselves are at this time experiencing difficulty in maintaining discipline amongst their members. Is a Government sponsored wages policy any more likely to earn the respect of the men than one supported by the unions alone? What guarantee is there that there would not be an even larger number of unofficial strikes against the national wages policy? To judge by the strike just concluded, the mere existence in one trade of higher wages, whatever the reason for them, might be made the justification for a sectional attempt to raise wages in another. Would not the attempt to impose a national policy thus contribute towards the creation of still greater strains than already exist in the trade union system? Would not salaries, at least in the lower grades, also have to be brought under the terms of the scheme and is it really desirable that scales of salaries should be laid down for the great diversity of work that staffs perform? More fundamentally, is it really desirable that an elected Government should concern itself so closely with settling wage rates? These are questions that need satisfactory answers before any attempt is made to impose national control on wages. We do not doubt the need at present to find some means of checking rising wage rates to keep them attuned to ruling rates of production. But we do doubt whether the "nationalisation" of wages is an effective way of doing it.

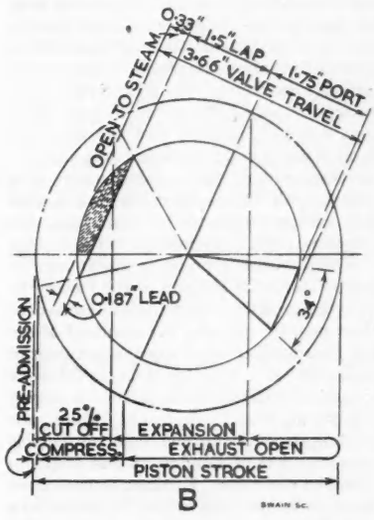
Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE VALVE GEAR

SIR,—I entirely agree with Mr. Harris in upholding the Stephenson link motion as used with modern large-diameter piston valves having long travel, as far as its performance is concerned. My experience of engines so fitted is that they are much livelier in acceleration and running than similar engines fitted with Walschaerts gear. For a given cut-off in the region of 25 per cent there is a greater opening at admission and exhaust, with the consequence that the m.e.p. and i.h.p. are increased for a given cylinder diameter and boiler pressure. This is made clear by the valve diagrams, A representing a gear with variable lead increasing to $\frac{5}{16}$in at 25 per cent cut-off, while B is that for a gear with a constant lead of $\frac{3}{16}$in. It will be appreciated that A gives 33 per cent more area in the opening to steam and 19 deg. more angular movement of the crankshaft during which the exhaust valve is full open.





The drawback to engines having the Stephenson gear between the frames is that they must be taken over a pit for oiling and inspection, whereas a Walschaerts gear on the outside can be attended to anywhere, a matter of importance at a congested engine shed.

From the mechanical aspect the Walschaerts has the pull as regards maintenance and freedom from heating. It keeps in order longer and can be reconditioned very cheaply by the renewal of small bushes and pins; thus it commends itself to those responsible for repair. The eccentric straps of the Stephenson gear require careful fitting if overheating is to be avoided; they have to be taken up when wear occurs and they use up more lubricating oil.

These drawbacks of the Stephenson gear would be overcome in the case of outside-cylinder engines if the gear was also placed outside. This could be done by the use of a narrow roller bearing eccentric of small diameter plus a return crank. Constructed as a unit, this pair could be drawn off the crankpin when removing coupling and connecting-rods, and the total width need not be much more than that of a return crank alone. In such a case the throw of the eccentrics should be kept down and proportioned in accordance with the length of the eccentric rods to obtain the most desirable leads at full and running cut-offs. The length of travel should be brought up by the intervention of a rocking shaft with suitably proportioned arms. This would give the best lay-out of gear where the valves are above the cylinders, especially if the upper arm of the rocker was moved inwards, thus bringing the steam chest nearer the frames and making a compact arrangement, as in the G.W.R. two-cylinder engines.

A link motion of this description would relieve the crosshead of the combination lever and connections necessary in the case of Walschaerts and Baker gears.

H. HOLCROFT.

Chipstead, Surrey, January 18th.

SIR,—I agree with Mr. K. N. Harris that Stephenson valve gear has not always been designed to the best advantage and that there are examples of it that do not give negative lead in full gear, but that does not affect, even slightly, the truth of the sentence quoted by him.

It may perhaps be added that in comparing different types of valve gear it is unnecessary, and possibly misleading, to consider any but the best existing form of each. Comparison between inefficient forms of different types may be meaningless.

It is not by any means certain that there is advantage in the marked increase in pre-admission angle produced by Stephenson gear, as it is "linked up." Rather may it be said that it is a desire to offset the effects of that character-

istic that is responsible for the adoption of negative lead in full gear.

W. A. TUPLIN.

Huddersfield, January 17th.

"WHERE DO WE GO FROM HERE?"

SIR,—The subject-matter of Mr. Rice's postulate in your issue of December 27th and his answers cover such an enormous field that in themselves they must act as a deterrent to any all-embracing attempt to constructive reply; but with no disrespect to his views, the fundamental doctrine from which he draws his conclusions is one which should not pass unchallenged.

"For forty-seven hours a week he is a robot, for 121 he is God . . ." I submit that each of these assumptions is based on misconception and is therefore completely fallacious. Let me endeavour to test this conclusion. Of the 20 million people in employment in this country, how many, in fact, are engaged in an occupation as limited and as changeless as a repetitive movement executed 862,000 times a year? It is certain that the fraction which they would represent is extremely small. Again, of that fraction how many are young people passing on from one process to another and engaged on such process for only a few weeks or months or, alternatively, are women who in the mass stay in industry for only a few years to pass on to marriage, a home, children and the domestic life which is and should be woman's sphere?

As to the residue, that small fraction of a small fraction, Mr. Rice's robot has his thoughts and his surroundings to interest him, his skilful fingers direct the sheet on to the tooling indices which ensure a precision result and he sees day by day from one end of the factory to the other the growth of assemblies destined to play their part in uplifting the standard of life to which his contribution of work is an essential link, and, when all is said and done, is the work widely different from alternatives involving apparently unlimited change? Take the London bus driver, who conducts his vehicle from the outskirts of London at one end to a destination at the other. Instinct, learned from experience, tells him to a matter of inches how narrow a channel he can pass through and the movements of his steering wheel, his gear lever, his throttle, and his brakes are all indexed from the passage of functions from the brain to the limbs in the same way as in the manufacture of successive pressings in picturing which Mr. Rice draws such discomforting conclusions. Both sets of movements become completely automatic with constant repetition, with far less difference between them, in fact, than the static nature of the factory worker's occupation as against the kaleidoscope of passing traffic, which the other evades during every minute of the time he is in motion would lead us to assume.

"For 121 he is God . . ." This assertion is demonstrably even more untrue than the earlier one with which it is linked. Mr. Rice's workman will be a trade unionist, but in my experience only a small minority of trade union members carry their unionism seriously into their homes. In the mass, trade unionists do the most incomprehensible, irrational things imaginable; but, taken as individuals, they are normal citizens, possessed of common sense in no small degree. Our friend is probably a married man, a father and perhaps a sportsman, keen on football, bowls, even dogs if he has a speculative outlook; the collective power he wields through his vote does not take up five minutes of his week except during an election, and even then only a tiny minority of his class go to any political meetings. Moreover, he may be, and often is, a good Christian, though he may seldom go to church; and, whatever he is, in 999 cases out of 1000 he is a very ordinary human being, possessing strength here, weakness there and subject to all the human frailties to which flesh is heir. It follows that Mr. Rice's thesis is basically inaccurate and, as a result, the conclusions drawn therefrom have no foundation in fact.

Coming now to his four suggestions, a wealth of statistical argument would have to be gone into to deal with them; but, broadly and without detail, it can be said that in many ranges of employment a great deal of the psychological contact between employers and employed, which the suggestions envisage, is already in being, not always by rule or by precise methods due to meetings and conferences, which, when held, are often abortive, but by day-to-day sympathy and understanding of the difficulties of either side, which, in my judgment, is far commoner in factory life than those inexperienced in its detailed organisation would imagine.

In considering this difficult matter of human relationships, which, I agree, is supremely important to the national life, let it not be forgotten that this country has successfully waged the two most destructive and widespread wars in the history of the world within the compass of a single generation, and we have emerged with the foundation of our democratic and Christian institutions still fashioning our way of life. We should, indeed, be a super people if the happenings between 1914 and 1946 had not undermined many of the moral standards of our national life, because war essentially debases human nature, notwithstanding its faculty of bringing heroism and courage into supreme prominence. Our greatest need to-day (and that of the world at large) is a long period of peace within which to remould our national, our family and our religious life, and, given that—even though it be through fear of the destruction of life and civilisation itself by atomic energy—out of evil good will ultimately come, because elevating and ennobling influences will have free play, and these, coupled with the advance of the sciences for the benefit of mankind, will bring him nearer to the standards his Maker intended him to reach than ever before in history. It is in that direction that I would venture to hope we go from here, and I trust that in the arguments developed and induced from Mr. Rice's article, I have not exceeded the limitations which the editor may consider appropriate to an engineering journal.

C. ATHERTON ATCHLEY.

Alloa, January 13th.

SIR,—Your publication of the article, "Where do we go from here?" by A. K. Rice, is both timely and wise. The author of this excellent article is to be congratulated on the appositeness of his title. At the very outset, he contrives to convince his readers that the stage is set for action and not for rehearsals. There has been a tendency of recent years to surfeit the engineering world with irresponsible talk about how industry should be organised to achieve certain ends. Most of these schemes suffer from a lack of fundamental knowledge, embracing both the operator and the work performed. In other words, it is the same error of the nineteenth century economists, who invented the imaginary "economic man."

Your correspondent, Frank L. Watson, in my view, fails to appreciate the true nature of his position when he attempts to differentiate between a mechanical problem and a sociological problem. So far as the engineer in industry is concerned, there is only one problem—the problem of man in a technological milieu. Furthermore, in attempting to apportion blame to any particular member of the industrial unit, he is less than just. If there is inefficiency in industry to-day, all parties must be held culpable. To approach the problem with preconceived notions will not help. Industrialism, like all other evolutionary developments, is suffering from a periodic strain, and requires the constructive approach during the present transitional phase. Mere recrimination serves only to aggravate the difficulties of adjustment to the changing outlook.

The wheels of industry are gathering momentum. The wise man will not attempt, like King Canute, to interfere with the inevitable. There is a contribution for each to make, and without that contribution now the uncooperative member defeats his own best interests, for the new understanding will most surely come, and, indeed, is already begun. Industry is not a congeries of separate parts, but an integrative whole; if one member suffers, then the whole suffers.

S. C. MCKENZIE.

Rugby, January 15th.

SIR,—On reading the article by Mr. A. K. Rice, in your issue of December 27th, a number of points occurred to me, which I set out below for what they are worth.

(1) Is it necessary to resort to gross exaggeration in order to support an argument? Workers in general are obviously not capable of "controlling . . . the destiny of an empire," and the mere act of voting is very remote from the actual shaping of national policies.

(2) The writer's statement, in reference to the factory worker, that "for forty-seven hours a week he is a robot, for 121 he is God," though again an exaggeration, contains an element of truth. It is also true, however, in a less degree, in the case of many others than factory workers. A clerk, for example, is tied during his working day to the calculation of figures and the making of entries which are of no interest in themselves, and even the teacher, though his work gives more scope, must during school hours bring himself down to the level of the very young, or the adolescent, and restrict himself to such teachings as they are capable of understanding.

(3) Many workers doing monotonous routine jobs appear quite content with their lot, provided that pay and conditions are satisfactory; they do not aspire to a higher grade of work and some are actually afraid of greater responsibility. Some outstanding individuals have shown that it is possible to rise from routine manual occupations to high and responsible positions if the will and the ability are there (though admittedly this would be more difficult to-day, perhaps, than it was, say, half a century ago).

(4) Although manual work in general is becoming more monotonous and less interesting, the number of hours actually worked has become increasingly less, so that there is more leisure time to follow other and more interesting pursuits; and this should help to some extent to counteract the effects of dull, monotonous work.

(5) It is agreed that "social progress lags behind technical knowledge." This has been true ever since the beginnings of the industrial revolution, when technical knowledge began to make such rapid strides. It is also true in the international sphere, and is not confined to industry. Is it not more or less inevitable, since technical progress depends on the discovery of scientific facts which can be subjected to measurement and calculation, whereas the social sciences are based on the characteristics of human nature, which is always unpredictable? The very techniques which are now being used in an attempt to deal with the social problem in industry, *e.g.*, personnel management, welfare work, psychological tests (which, if properly conducted, should help to prevent the square peg in the round hole), medical examinations, &c., are criticised by the writer on the grounds that they are "beginning to take the place of

the human beings to whom they relate." But what expedients does he offer to take their place? With regard to the suggestions made :—

(i) Consideration of a man's ability to get on with his fellows : this is admittedly a necessity for the attainment of satisfactory relations in the workshops ; but surely it is a consideration which is taken into account by anyone experienced in engaging men.

(ii) Opportunities for promotion : in many industrial concerns there are good opportunities for promotion, and every encouragement is given for education and training to young workers who show promise.

(iii) Justice : good management should, and does, aim at fairness and impartiality in dealings with employees.

(iv) Joint consultation :

(1) It is doubtful whether such methods as this provide a means of counteracting the monotony of routine work. It is impracticable for all workers to take part in such consultation, except through the medium of representatives, and the mere act of voting for such representatives can hardly be expected to inspire workers with the feeling that they are "contributing positively to the well-being of the organisation of which they are a part."

(2) Joint consultation may be a useful way of getting grievances aired, and of putting the workers' point of view before the management, but it has its limits as far as decision-making goes ; for it must be admitted that workers in general have not the necessary training and knowledge (quite apart from any question of ability) to assist in the administration of large businesses, administration being a specialised function.

(3) A further point is that refusal of the management to carry out suggestions from workers' representatives which it knows to be impracticable may result in a feeling of resentment in the workers, and a belief that their ideas are being boycotted.

Taking the article as a whole, it seems to me that, first, the writer has over-stated the problem ; and secondly, has not offered any real solution for remedying the situation as he sees it.

J. Gregory.

Sheffield, January 20th.

AGRICULTURE AND ENGINEERING

Sir,—Concerning the mechanisation of farming operations, as many engineers will have seen, there are a large number of the processes in farming which could no doubt be mechanised and save a lot of labour, but, as Mr. Broadfoot states, there are grave difficulties to be overcome before some of these problems can be satisfactorily solved. Mr. Broadfoot rightly states that farmers should have cheap electric power, but it would appear to me it is a problematical question whether they will ever get it, simply on account of the expense of carrying the mains to the farmers and installing the fittings. From enquiries I have made, this is a very expensive job, and as by far the larger proportion of the farms in England are under 250 acres and therefore on the small side, it is a matter of finance largely, and I do not see how the larger majority of farms will ever have electric power fitted, for that reason, and the same applies to piped water.

Regarding mechanising the farming industry, many of us could name laborious and backaching jobs which could be better done by machinery—for instance, a complete potato harvester, a hop picker, turnip and mangold singler, the farmyard muck loader, sugar beet and swede harvesters. These are some of the operations which most farmers have to cope with and are common, everyday jobs. If they could be mechanised it would save much time and labour. Of course, I am aware that a number of these operations are now being tackled with more or less success ; there are also many more operations which have been more or less solved, such as hay-loading, elevating. The combine harvester will, no doubt, do a lot, but then there is the problem of drying, and it is completely outside the financial capacity of small farmers to pay for a combine or a dryer. Furthermore, combine harvesting may not be altogether solved when used by contractors, as many farmers want the machine at the same time to cut and thresh their crops, thus making it difficult for the contractor. When McCormick brought out his first self-binder, it went a long way towards solving corn harvesting, but then there was the labour of stooking and leading it and the corn got spoiled in the field if it was a wet season, whereas the combine does not suffer from that drawback.

We come back to the question of finance again, the farmer cannot buy these expensive implements when they only work about one month per year. This is an item which is often overlooked by engineers, probably as with a machine tool or typewriter, say, these are used twelve months in the year and, therefore, can pay good dividends, but with a farmers' implement, he can only use it in the season, which is once per annum and only about a month at that, with the result that it is idle eleven months out of the twelve. The threshing drum, of course, does not suffer from this, threshing contractors can buy them and do threshing six months in the year, probably. With a combine, of course, the threshing drum is not needed, although the harvest is not finished when the combine harvester has done with it, as the corn has to be dried.

No doubt, a number of these farming operations will be mechanised, but even so, a large number of the farmers in this country could not afford to buy some of the major implements and machinery referred to. It is to be hoped that the Government will look after agriculture in future, better than it did after the first world war.

W. Duckitt.

Streetly, Staffs, January 14th.

OVERTIME IN THE DRAWING-OFFICE

Sir,—The views on the above subject, expressed by "Draughtsman" in your issue of January 17th, correspond in large measure with the experience of anyone responsible for drawing-office production work. There can be no doubt that efficiency drops after a "tiredness" point has been reached, but it is not easy to ascertain when that point comes. To some extent this depends on the working conditions, including light, air and other amenities.

Regular overtime, in the ordinary sense of the term, is not only undesirable from a production viewpoint, but becomes progressively less effective.

These are generalisations, however, and require to be related to the length of the working week. For example, I have in mind a drawing-office attached to a firm which formerly worked a 5½-day, 44-hour week. The drawing-office was paid overtime, but most of the other departments were not so. A 5-day, 40-hour week was then adopted without wage adjustments. With such a comparatively short working week it could scarcely be contended that a severe fatigue point was reached. Hence, the alternatives were loss of four hours per person or the introduction of regular overtime. So far from reaching exhaustion point, it was found that practically all members of the drawing-office staff were using their new-found leisure to take private work for other firms, and I feel that the policy adopted of adopting regular weekly voluntary overtime for four hours (at overtime rates) accorded with good commercial principles of accepting what the employer wished to offer, and the employee wished to sell and would otherwise have sold elsewhere.

Charles E. Lee.

Westminster, S.W.1, January 17th.

Nationalisation of Gas and Electricity

The Federation of British Industries—representing a very large body of consumers of gas and electricity—has been giving careful consideration to the proposal of the Government to nationalise these services. After full examination, the Federation can see no evidence to suggest that this course will bring any advantage to industrial consumers. The Federation, moreover, is apprehensive that increases in cost and lower standards of service to the industrial consumer will result from the establishment of vast administrative units of the pattern now becoming apparent. A representative committee of consumers has reviewed the question from the point of view of quality of supply, cost, and standard of availability and service offered. Its conclusions are : that judged by the criteria just indicated, past services, with few exceptions, have been satisfactory, and both industries have maintained continuous progress over a long period ; that both industries have adequate proposals—by way of amalgamation and grouping—to overcome limitations to further progress due to existing structure and legislation ; and that both industries are alive to the need of extensive technical developments, and have both the plans and the funds ready for this purpose. For these reasons, the Federation reiterates its strong objection to the Government's proposals.

Lloyd's Register Shipbuilding Returns

The statistics issued by Lloyd's Register of Shipping, with regard to merchant vessels under construction at the end of December last, show that in Great Britain and Ireland there is an increase of 62,184 tons in the work in hand, compared with the figures for the previous quarter. The present total of 1,937,062 gross tons is also greater by 324,252 tons than the tonnage which was being built at the end of December, 1945, and has not been exceeded since March, 1922, when the total recorded was 2,235,998 tons. At the end of December the tonnage on which work was suspended amounted to 10,942 tons. About 478,000 tons, or 24·7 per cent, of the tonnage now being built in this country is intended for registration abroad or for sale. The tonnage of merchant vessels under construction abroad at the end of December is shown as 1,741,419 tons gross, which is 47,138 tons more than that recorded at the end of September last. No figures, it is noted, are included for Danzig, Germany, Japan, Poland and Russia, but French figures are more comprehensive. The total tonnage under construction in the world, excluding the countries above mentioned, amounts to 3,678,481 tons gross, of which 52·7 per cent is being built in Great Britain and Ireland and 47·3 per cent abroad. During the quarter under review, in Great Britain and Ireland, 339,060 tons were commenced and 267,760 tons were launched. Similar figures for abroad are 219,746 tons commenced and 254,229 tons launched. Steam and motor oil tankers of 1000 tons and upwards under construction in the world amount to 69 vessels of 596,359 tons ; of these, 34 vessels of 282,825 tons are being built in Great Britain and Ireland. Of the total under construction in Great Britain and Ireland at the end of December, 997,329 tons were steamers and 931,528 tons motorships. At the same date the tonnage being constructed abroad comprised 634,722 tons of steamers and 1,106,697 tons of motorships.

Axial Flow Gas Turbine

THE INSTITUTION OF MECHANICAL ENGINEERS

AT an extra general meeting held at the Institution of Mechanical Engineers on Friday, January 10th, a paper by D. M. Smith, D.Sc., M.I. Mech. E., entitled "The Development of an Axial Flow Gas Turbine for Jet Propulsion," and a paper by K. W. Todd, M.Eng., A.M.I. Mech. E., entitled "Practical Aspects of Cascade Wind Tunnel Research," were read.

Discussion

Dr. H. Roxbee Cox, in opening the discussion, said that to many people the "F 2" engine had become quite a familiar shape, and if they were asked what was the typical aircraft axial compressor engine, they would be inclined to point to it, but he thought it was true that there was still one feature of it which was unique, and that was its combustion chamber. That engine started with an annular combustion chamber which was a single chamber, as Dr. Smith had pointed out and he thought it was true to say that all the other engines which had been developed in this country had had instead a number of discrete chambers, varying in number from six to sixteen. Both types of combustion system had had their difficulties in development, but probably the easier course was followed by the people who developed the multi-chamber type of combustion system. He himself and many others had followed the developments on the annular chamber with very great interest, and some of them had wondered whether it would ever be successful; but he thought that it had now reached a stage when the Metropolitan-Vickers Company were very satisfied with it, and there was not the least doubt that that type of combustion chamber would be of very great advantage in its application to the type of engine in question, because inevitably it must save room, and in an aircraft that was something which it was most important.

He had mentioned that there were two lines on which the gas turbine engine for aircraft had developed in this country. There had been a certain amount of competition between the two forms. They had probably had a mutually stimulating effect, and there was not the least reason to suppose that one was likely to displace the other because, in his opinion, the centrifugal engine had a field for itself and the axial engine also had a field for itself; nevertheless, the competition between them would be maintained, because there was still another field in which they could both be used. That competition was going to be very good for both of them.

The axial engine was going to have to compete with the centrifugal engine in the matter of weight, and he would like Dr. Smith in replying to the discussion to say something about the prospects of reducing the weight of that type of engine. It was doing extraordinarily well. Tracing its history, it would be found that it was getting more and more pounds of thrust for relatively small increases in pounds of weight. Reference was made in the paper to 3500 lb of thrust for 1750 lb of weight, which was a very good figure, giving a ratio of 2 : 1, and it was also stated that the same engine had given 4000 lb of thrust, which raised the ratio to slightly over 2·28 : 1. At the present time, however, the centrifugal engine could show a figure of 3 : 1. He hoped that the axial engine was going to get into the same region, and that the mutual stimulus of the two types would continue.

On specific fuel consumption, the axial engine certainly made a good start, and for a long time it was showing better figures for fuel consumption in terms of pounds of fuel per pound of thrust per hour than the centrifugal type. Intrinsically he felt that it should always keep ahead. It had not always done so, but he felt that the potentiality of the high compression which the axial compressor could produce must in the end make that type of engine the more economical of the two.

In his paper Dr. Smith referred, apparently with mixed feelings, to the flying test bed.

As Dr. Smith rightly said, the proper thing to do was to have an altitude test chamber, and personally he did not think that it was giving any secrets away to say that that was the aim of the proper authorities, and in due course he was sure that a very adequate altitude test chamber would be provided.

Dr. Livingstone Smith said that an important point in connection with the problems of axial flow compressors was, of course, their efficiency. He would like to ask the author what was the true compressor efficiency that was obtained for the "F 2" compressor. Another matter of some importance was the behaviour of the bearings, a failure in which might be disastrous. There were two schools of thought as to whether ball bearings or plain bearings were more suitable for the type of machine in question, and it would be very interesting to have more details of the bearing failures referred to in the paper. For example, in the paper it was indicated that initially, owing to the bearing temperatures rising excessively with speed, a number of bearing failures were experienced, and later improved cooling arrangements were necessary in order to bring the engine to a condition suitable for flight. Were the failures due to failure of the cage or to the reduction in radial clearance, or to what were they to be attributed? The effect of temperature on the behaviour of ball bearings was extraordinarily interesting, and from the gas turbine point of view was very important.

It was also interesting to see that the author referred to blade failure by fatigue in the root. In the early stages of the development of jet propulsion units, when new materials were being sought, there was a preponderance of opinion that creep was a significant property, and for a long time he had been almost a voice crying in the wilderness in arguing that fatigue was an equally important factor. However, the first failures that he saw were fatigue failures, and he would therefore like to ask whether the author had ever had any instance of actual creep failures. He did not mean of the blade elongating sufficiently to rub against the casing, but of actual creep failure.

Professor O. A. Saunders remarked that the rival merits of annular and separate combustion chambers had, of course, been debated many times. Personally, he thought that the argument in favour of the annular chamber must rest on two assumptions. The first was that the combustion chamber was the feature which was limiting the size of the engine, and the second was that it was possible to utilise fully the whole of the area presented by the annulus, which, of course, was greater than would be presented for air flow by a series of discrete chambers. The first question as to whether the combustion chamber limited the size or not was, he thought, answered in the first place in the affirmative, though the author had mentioned that in later designs the turbine, in order to keep it single-stage, was becoming so large that the combustion chamber was no longer the limit. Moreover, in future developments of the jet propulsion engine it seemed obvious that in order to attain higher fuel economy the compression would have to be increased, and in such developments the combustion chamber might well not be the limiting factor, since the higher density would enable the chamber to be smaller for the same mass flow in any case. However, whether in the future the annular chamber or the discrete chamber was used was a matter on which he would not like to prophesy, and in any case the development of the project described had certainly given a "flip" to the annular chamber.

He thought it was clear that if the axial compressor was to attain its full use in the aircraft field, the number of stages used must be reduced, and he would like to know whether the author thought that this was a possibility for the future. The paper did not mention what type of blading was used and what allowance was made for centrifugal effect, and whether the blades were vortex blades or not, but he felt that perhaps too much attention had been paid to making the blades keep the centrifugal force balanced at the expense of getting more work out of each blade.

Compressor Efficiency

An efficiency diagram shown gave the characteristics of the "F 2" compressor, and the author had already been asked what that efficiency meant. He would like to see the working line of the engine put on that diagram, because it seemed to him that with a stalling curve of the form shown it must be very difficult to fit in a satisfactory working line, and, as that line must not cross the stall at full speed, that might, on that diagram at any rate, result in an engine of rather poor acceleration. He would like to know whether the author had any comments to make.

Dr. G. A. Hankins said that it so happened that they had in the engineering division of the National Physical Laboratory an axial flow air compressor which seemed to be about the same size as the "F 2" compressor. Their compressor was of foreign manufacture, with fourteen stages, and he believed that at the time when it was made, about 1935, it was recognised as being a really good machine. Moreover, he thought that he was right in saying that at that time, and, in fact, until the gas turbine developments took place during the war, no axial flow compressors of any sort were being made in this country. That compressor at the National Physical Laboratory gave the air supply of their 11in supersonic wind tunnel, which was a return-flow wind tunnel, and they had been able to make fairly exhaustive performance and efficiency tests of that compressor. The maximum pressure ratio which they obtained from it at top speed (about 6500 r.p.m.) was 4, and the maximum efficiency at the design pressure ratio of about 2·8 was just about 75 per cent, whereas the author's figures went up to nearly 90 per cent, and, whatever allowances were made, the figure would be well above 75 per cent. The N.P.L. compressor was, as he had said, of foreign manufacture, but was a really good machine, but since 1935, when it was made, the efficiency

had gone up, as a result of the developments in question, by at least 10 per cent, and possibly 15 per cent.

Fuel System

Mr. C. A. Pugh remarked that the single-stage positive displacement gear type fuel pump, which worked with an outlet pressure of up to 1000 lb per square inch, had to handle the fuel without the addition of the 1 per cent of lubricating oil which other gas turbine manufacturers seemed able to tolerate. That requirement necessitated extensive research to find materials to stand up to this arduous duty, and work was still continuing. Because the general unreliability of fuel pumps necessitated it as a safety precaution, two pumps were fitted to all gas turbine engines installed in aircraft. The time was not far off, he hoped, when one pump would suffice, as, if this could be achieved, then the all speed governor control unit which had been tried out in prototype form on the engine, and which, as the result of an encouraging performance, was being further developed, offered a very compact form of fuel supply and control when built integrally with the pump. The function of the all-speed governor was to control the excess flow or spill from the positive displacement pump, so that the engine received just sufficient fuel to maintain any preset speed, and any deviation from the set speed was corrected by the adjustment of the spill. In this way the fuel control was sensitive only to engine speed, and the barometrically controlled relief valve and the overspeed governor-operated relief valve were dispensed with, as the correct amount of fuel was supplied to the engine for a given speed, irrespective of its operating altitude.

When an airscrew was fitted to the gas turbine, the present arrangement of the fuel system would become even more complicated. It was because of this that he would like to have the author's opinion of the practicability of utilising the turbine stator blade temperature as a basis for the control of airscrew pitch. Such a scheme, used in conjunction with the all-speed governor control unit, would allow the engine to be operated at optimum load under all flying conditions. It was hoped to develop a scheme of that type, in which thermocouples were sunk into a number of stator blades in order to register an average temperature and by electronic means use the temperature signal to operate a servo-motor to control the airscrew pitch-changing mechanism. The airscrew pitch would then be adjusted to prevent overfuelling of the engine, which an all-speed governor control system tended to do if the engine revolutions were dropping. In the opposite direction, of course, the propeller blade angle would go towards maximum whenever the stator blade temperature was below the optimum. He knew that the all-speed governor control was not yet fully developed, and the author might wonder why he had suggested complicating this development by introducing an airscrew; but, as the paper indicated that most of the problems on the engine had been solved, he hoped that the author could now find time to consider the suggestion.

Mr. A. D. Baxter said he was surprised that so far in the discussion there had not been any comment on the similarity of the "F 2" to the German engines. The resemblance was particularly marked in comparison with the "BMWOO 3" engine, which had an annular combustion chamber similar in many respects, externally at any rate, to the "F 2" including even the same type of fuel injectors; but that engine had one feature which the "F 2" did not possess, namely, a variable-area propelling nozzle. It was surprising that the Metropolitan-Vickers Company had not developed such a component, because it would assist very much in easing some of the problems of the axial engine starting, reducing the idling thrust and increasing the acceleration rate, and it might possibly have replaced the blow-off valves, the accelerated fuel controls and so forth which had been necessary in the past.

Combustion

Turning to the combustion problem, he would like to add his congratulations to the firm on its continuing faith in the annular chamber. There had been some struggles over it. In fact, it could be seen from a figure in the paper that the "F 2" chamber had originally an overall length of only 22in, and that the flame path was less than 20in. In addition, the heat release demanded was of the order of 2,000,000 C.H.U. per cubic foot per hour. For comparison, the flame tube types had flame paths varying between 40in in a contra flow design and 29in on a straight-through type, and their heat releases were less than 1,000,000 C.H.U. In the present "F 2" chamber the heat release was only 1,400,000 C.H.U. per hour, and in the present flame tube types there were flame path lengths which were still something over 30in.

Mr. R. J. Eldred said Mr. Baxter had referred to the combustion chamber and to the high rate of heat release which was going on in that chamber. Those rates of heat release were getting somewhere near the conditions of a continuous explosion (if one could consider such a thing), and the troubles which had been associated with the chamber had been due, as he thought that Dr. Smith would agree, to inequalities and instabilities in the flames in the primary chamber. The Metropolitan-Vickers annular chamber used an upstream spray, and this thin pencil of fuel was trying to make headway against the air stream. It was buffeted on each side by the virtual explosion which was going on all round it, so that it was not surprising that Dr. Smith got disturbances and inequalities. Admittedly the annular chamber had reached a certain degree of reliability, and the firm deserved congratulations, but now that its designers had got so far, thought might be given to whether they were or the right lines or not. Many things could be brought to a stage where they would work, but that did not mean that they were necessarily the best.

He would like to say a word about the accessories, to which Mr. Pugh had referred. The gas turbine engine was a complete power house, equivalent to a stoker boiler and turbine all in one, and to deal with it by controlling the fuel was like trying to control the steam turbine by varying the feed to the boilers; there were time lags all over the place. It would be interesting to know whether Dr. Smith had any test information on such time lags and the application of any successful speed governor system to the plant. It would seem that any successful type of speed governor would require some form of anticipatory gear in order to take account of and deal with the time lags.

Author's Reply

Dr. D. M. Smith, in reply, said that a number of speakers had referred to the conventional compressor characteristics and had asked what was the true compressor efficiency. The answer to that was that he did not know. The way in which the conventional compressor efficiency was measured depended on measuring total heads at mid-height, and the big cause of discrepancy between conventional efficiency and true efficiency was the very extraordinary velocity profiles which were obtained on the outlet of the compressor, and which differed from point to point on the compressor characteristic. The true efficiencies were certainly several per cent below the conventional efficiencies, and the true efficiency depended upon the method of definition which was used in making allowance for the very varying total heads at the compressor outlet. On compressor tests so far they had had to depend for efficiency measurements on temperature efficiencies alone, as apart from one early test they had had no independent check of the input to the compressor. That indicated a very desirable improvement in their compressor testing equipment, which, he hoped, would be effected soon.

There had been a good many references to the annular combustion chamber and its problems. The development of the annular combustion chamber had been slow owing to the necessity of that development being so largely empirical, and so largely carried out on the engine itself; but it had now reached the same degree of reliability as the other high-temperature components.

Time would not permit him to reply to the questions raised about the control gear, but with regard to the future prospects of the engine, a point mentioned by Dr. Roxbee Cox and other speakers, he was sure that specific weights of axial flow jet propulsion engines could be substantially reduced in future designs. One of the means of accomplishing that was to use a larger number of different blade sections in the axial flow compressor, because by using different blade sections the compressor could be shortened. Another way, referred to in the discussion, was to get a bigger pressure rise per stage, which could be done by changing the aerodynamic design of the blading and adopting higher peripheral blade velocities; but the adoption of higher peripheral blade velocities necessarily meant the abandonment of the drum design which had been used so far. It would be done by some kind of disc design.

Another means of lightening the compressor and one which might come as a surprise to Dr. Hankins, who referred to light alloys, would be by changing from light alloys to steel to a certain extent. He was satisfied that a lighter engine could be built with a compressor which was to a greater extent of steel than was the case with the "F 2" compressors. He was sure that the annular combustion chamber would remain, and would be more widely adopted in the future development of jet engines.

The World Power Conference.—The central office and office of the British National Committee of the World Power Conference have been removed to more commodious premises at 201–202, Grand Buildings, Trafalgar Square, London, W.C.2 (telephone, WHItehall 3966). The Conference also announces that the first post-war edition of the "List of National Committees and Representatives" has been issued and copies are obtainable from the secretary of the International Executive Council, Mr. C. H. Gray, at the above address. As the list shows, there are at present twenty-six National Committees and seven other countries possessing accredited representatives, giving a total of thirty-three member countries. This compares with forty-four member countries in 1939, and the reduction is partly accounted for by the fact that ex-enemy countries are not at present eligible for membership of the Conference, and partly by the fact that certain pre-war member countries (*e.g.*, the Baltic States) have ceased to exist as independent States. The arrangements for the next sectional meeting of the World Power Conference are well in hand and an impressive collection of British contributions to the Conference will be presented. Full particulars of titles, subjects and authors will be released shortly.

Interchangeability of B.S.W. and American National Nuts and Bolts

(Communicated by the National Physical Laboratory)

In connection with the recommendation of the 1945 Ottawa Conference on the Unification of Engineering Standards to standardise a common British-American "unified" screw thread, the B.S.I. Screw Threads Technical Committee desired evidence of the degree of interchangeability of bolts and nuts made with the Whitworth and proposed "Unified" thread forms. In practice this question of interchangeability would arise only in connection with the recommended "Unified" coarse-pitch series and the British Standard Whitworth (B.S.W.) series, since these series, in common with the American National Coarse thread series (A.N.C.) have the same diameter-pitch relationships in the majority of sizes.

The proposed "Unified" thread form approximates closely to the American National form of thread, and an investigation was made at the N.P.L. on the interchangeability of certain sizes of B.S.W. (medium fit) and A.N.C.2 bolts and nuts. It is considered that the results obtained can be taken as applicable to the interchangeability of B.S.W. and the proposed coarse-pitch series having the "Unified" thread form.

Calculations show that the possible interference is greater between a maximum metal A.N.C. nut assembled with a maximum metal B.S.W. bolt of the same nominal size than between a maximum metal B.S.W. nut assembled with a maximum metal A.N.C. bolt of the same nominal size. The more difficult case of assembly, viz., A.N.C. nut on B.S.W. bolt was therefore chosen for the investigation.

Samples of Nuts and Bolts.—Several hundred bolts of each of the three commonly used sizes, ¼in, ⅜in and ½in B.S.W. were used. These bolts, which were obtained from an engineering store in small batches, were apparently from a number of manufacturers and there is no reason to believe that they were not generally representative of current practice.

The corresponding sizes of A.N.C.2 nuts were obtained partly from the spares store of a motor manufacturing firm and partly from a nut manufacturer. Some were hexagon and some square.

Conditions of Test.—The screw threads on the bolts and nuts were brushed and in some cases wiped with a paraffined rag to remove swarf and dirt.

All the nuts of any one size were thoroughly mixed, and then each B.S.W. bolt was assembled first with a hexagon A.N.C.2 nut, secondly with a square A.N.C.2 nut (if available) and finally with a B.S.W. nut. The criterion of an acceptable assembly was that it should be possible to screw the nut on the bolt, using the fingers only, until the leading thread of the bolt showed clear.

Results of Test.—The results for several batches were not homogeneous with the remaining results; at least one of these batches of bolts was carefully examined and the threads found to be tapered and oversize in places. The B.S.W. nuts supplied with these bolts only fitted because they were correspondingly oversize. Excluding these results, the percentages of misfits in the assembly of ¼in B.S.W. and A.N.C.2 nuts with B.S.W. bolts were less than 5 per cent, and for the ⅜in size about 10 per cent in both cases, *i.e.*, for these two sizes there was as great a probability of a misfit occurring with a B.S.W. nut on a B.S.W. bolt as for an A.N.C.2 nut on a B.S.W. bolt.

For the ½in size the difference between the results for the two kinds of nuts was more noticeable. The percentage of misfits in the assembly of ½in A.N.C.2 nuts with B.S.W. bolts was about 50 per cent, whereas the corresponding value for the B.S.W. nuts was of the order of 20 per cent.

It should be pointed out that in the majority, if not all, of the cases, where a nut could not be screwed on with the fingers, there was a strong suspicion that the trouble was due to small bruises on the threads, and that assembly would be possible by the use of somewhat greater force than could be applied merely with the fingers. For several batches, chiefly on the ½in size, this was proved by screwing on all the "misfits" by hand, instead of the fingers, and without having recourse to a spanner.

A Large Transformer for France

An interesting contribution towards the development programme of the French electricity network to meet industrial demands has been made by the British Electric Transformer Company, Ltd., of Hayes, Middlesex (in association with Crompton Parkinson, Ltd.), who recently completed the construction of a 50-MVA, 150/15·6-kV transformer for the London Mission of the French Ministry of Industrial Production. The unit, which was recently shipped for France, will be installed at the Vendin station of the Société de Transport d'Energie Electrique de la Region du Nord.

50 MVA Transformer and Cooler Unit

The equipment consists of a three-phase, 50-cycles, star/delta transformer fitted with a twin "A" type cooler unit, as shown in the accompanying illustration from a photograph taken at the maker's works. Transformer cooling is ON/OFB, the artificial system being controlled thermostatically to come into operation at 50 per cent load. On-load "L.S." tap-changing gear provides a voltage-regulating range of 30 per cent (plus or minus 15 per cent in twenty steps).

Because there is insufficient headroom in the site workshop to allow the transformer carcase to be lifted vertically, the unit was specially constructed with an end door in the tank to allow the carcase to be removed horizontally. The carcase slides into the tank on rails and is pulled in by a tackle at the opposite end of the tank.

Special provisions have also been made to facilitate transport of the equipment in France. The transformer and the cooler unit are designed to be fitted with bogies carrying flanged rollers mounted in roller bearings, so that the separate units can be moved on standard French gauge railway systems, or on the special tracks provided for moving the equipment into position on site. The total weight of the complete equipment is approximately 112 tons, while the transformer carcase in its tank weighs 82 tons.

The Electricity Bill

Following on a meeting of representatives of the companies' side of the electricity supply industry in London, at which it was unanimously resolved to oppose the Electricity Bill as being contrary to the public interest, the Public Relations Committee issued the following statement:—

The public is warned that the Bill puts politics first and that it has been framed primarily to bring an efficient and progressive industry under political management.

Government spokesmen have admitted that, following nationalisation, the coal industry is bound to be in a state of flux for a number of years. To create a state of confusion in the electricity supply industry—the more important of the two remaining major fuel industries—is to run the gravest possible risk of a complete breakdown in the nation's industrial system.

The Bill seeks a monopolistic control of the industry, without any protection or advantages to the public. The Board to be set up can in fact dictate its own charges. The Consultative Councils, on which consumers will be in a minority, will have no real powers. There will be no appeal to an independent judicial body.

The code whereby electricity employees can claim compensation for loss of employment or alteration of status now in the Electricity Acts is swept away. Under the Bill the whole of this problem is left to the Minister of Fuel and Power, who is to make fresh regulations on these matters. These regulations cannot be amended by Parliament, which can only pass or annul them.

The Bill provides for an extreme measure of centralisation in place of the present decentralised system, which has always proved both flexible and efficient.

While the area boards are setting up their organisations, which must mean further additions to the ranks of bureaucracy, all the plans prepared by the companies for development will be halted, and no other plans can immediately take their place.

In spite of the many statements regarding the need for nationalising the industry so as to make supplies available in the countryside, there is not a word in the new Bill putting any obligation on the new Boards to develop rural supplies.

The compensation clauses of the Bill, by which companies are bought out on Stock Exchange values, are nothing more nor less than spoliation.

The Development of an Axial Flow Gas Turbine for Jet Propulsion*

By D. M. SMITH, D.Sc., M.I. Mech. E.†

(*Continued from page 82, January 17th*)

WHEN a compressor running on test at fixed speed is throttled to the neighbourhood of the stalling line, the compressor either surges or plunges into the fully stalled condition, in which condition the pressure rise and the efficiency have low values. On the F2 engine the compressor does not surge, but plunges into the fully stalled condition if the operating point on the compressor characteristic reaches the stalling line. Stalling marks a limit of stability, and appears to be influenced by very slight changes in operating conditions, which cause the observed stalling point to vary slightly in successive tests. The test stalling line usually exhibits a kink, as is shown in Fig. 4, for a flow of about 25 lb per second. Below this kink, stalling appears to be initiated at the first stage of the compressor; above this kink, stalling is initiated at a later stage, the stage in question moving towards the high-pressure end as the speed rises.

Traversing tests carried out on the later compressors have shown that conditions are reasonably uniform at compressor inlet, but that there is considerable radial variation of velocity and total head across the outlet passage. This radial variation changes greatly with operating point on the compressor characteristics. The true compressor efficiency is therefore less than the conventional efficiency, and is affected by the assumptions made in averaging the outlet total head. In an engine of the F2 type this radial variation has profound effects on the diffuser at compressor outlet, and on the combustion chamber which follows.

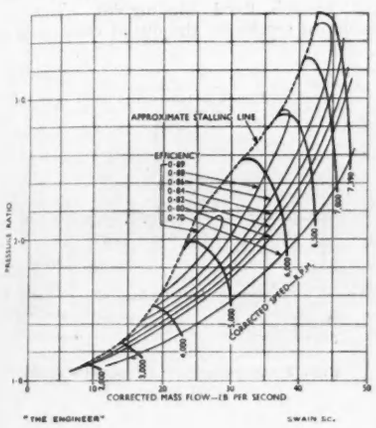


FIG. 4—*Conventional Test Characteristics of First F2 Compressor*

The progress of compressor development has been closely bound up with the development of inspection technique for compressor blading. In the earlier F2 compressors, the variations in blade section or setting called for by the designer were sometimes comparable with the unintended variation of blading sections as manufactured. Far more accurate methods of inspection have since been brought into use, and satisfactory records are now kept of the blading of every compressor.

All F2 compressors have been built of aluminium alloy materials. The usual materials have been RR.56 for the blading, RR.56 forgings for the drum, and RR.50 castings for the casing, and inlet and outlet branches. The blading for the earlier compressors was machined from rectangular bar; lately they have been made from pressings. At first the pressings delivered were of poor form and had to be hand ground to gauges; indeed, years of struggle were required to obtain pressings of a quality and accuracy which permitted them to be used without extensive machining or grinding of the working surfaces.

Trouble was experienced on some first and second-batch compressors, due to fatigue failures on the first row of moving blades. It was found that these blades were in resonance with disturbances from the six ribs in the compressor inlet at about 6500 r.p.m. On third and fourth-batch compressors the number of ribs was increased and there has been no vibration trouble. Trouble has also been experienced with RR.56 blade pressings due to intercrystalline corrosion, the prevention of which requires very careful control during manufacture. This trouble has not occurred with blades machined from rolled bar. The axial root fixings used for compressor blading have been entirely satisfactory—a dovetail root being used for the fixed blades and a shallow serrated root for the moving blades.

Drum construction has been used on all F2 compressors. The Mach number characteristics of the type of blading limit the peripheral speed to a value which gives permissible stresses in drums. The drum forgings required were larger than had been previously made in RR.56, and at one stage of the development they caused much anxiety. The required material properties were difficult to attain and many forgings were rejected. Co-operation between the material suppliers and the company's research department, with stringent control during manufacture, led to a gradual improvement in the technique of forging and subsequent treatment. There is now an ample margin of safety in the light alloy drums.

The light alloy castings have frequently been a source of delay in building engines of new design. Certain alloys easier to cast than RR.50 were found inadmissible on account of inferior temperature properties. RR.50 has, of course, been cast successfully in large-scale production, but on a new casting of any complexity, the founder requires to develop a casting technique by trial-and-error methods in order to produce castings to the high standard required for flight clearance.

Combustion Chamber.—Combustion chamber development has throughout followed one main course—the development of an annular combustion chamber with upstream injection from plain fuel jets—but some work has also been carried out on alternative lines.

The initial design of the first combustion chamber—that for the B10 plant—was based on small-scale rig tests made at the R.A.E. This chamber was a pipe type chamber with an annular primary, and was erected for rig test on the roof of a building, air being supplied through ducting from the B10 compressor, which was driven by the steam turbine, as in a compressor test. A series of modifications to the chamber was made on rig test, and ultimately good combustion was obtained over the required range of conditions. It was possible to test this combustion chamber on rig test at full working pressure as well as at atmospheric pressure. The developed combustion chamber gave no trouble on the B10 plant. Conditions were easier on this plant than on later engines, owing to the relatively low heat release and the long path to the turbine blading.

When the B10 plant tests had been completed the B10 compressor was arranged with steam turbine drive in a special building, and was run to supply air for rig tests—an annular chamber for the D11 engine being developed on this rig test equipment. These tests had to be limited to atmospheric pressure as the B10 compressor did not give sufficient pressure rise or mass flow for full-load D11 conditions, which engine, as already mentioned, was never completed.

The first F2 engine was being designed while these D11 rig tests were in progress, and the F2 requirements were kept in mind. The F2 combustion chamber design for the initial build was based largely on the D11 rig test experience. Air supply limitations prevented rig testing of the F2 chamber, even at atmospheric pressure. For a time the combustion rig test work was confined to segmental and other small-scale research and to the development of flame tubes as a possible alternative to annular chambers.

Early development running on the F2 engines brought to light some of the troubles which beset highly rated combustion chambers for jet propulsion. These troubles included "hot-spots" on the combustion chamber casing, and turbine blading, flame penetration through the turbine blading, primary chamber distortion, and various types of carbon deposit. The F2 annular chambers were, however, little subject to certain troubles which affected the early development of other types of engine. The combustion efficiency was usually high, smoke was seldom emitted, there was little trouble with the fuel jets, unintended extinction of combustion never took place, and there was relatively little cracking of sheet metal work.

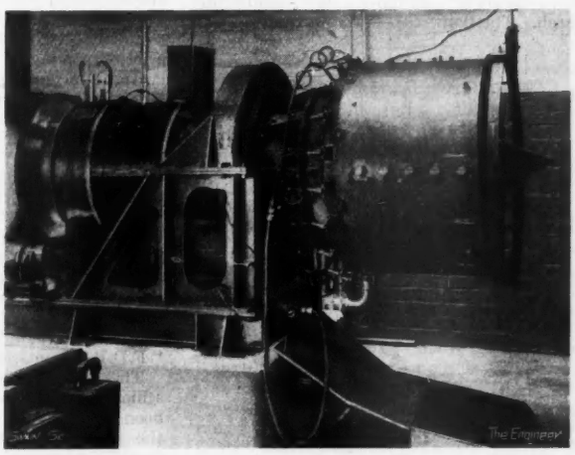


FIG. 5—*Combustion Chamber Test Rig*

The combustion chamber design requirements were not easy to attain. It was desired to have temperature distribution at turbine inlet uniform except for narrow cool bands at the inside and outside diameters, and this had to be maintained over the full operating range of conditions. Compromise was often called for in design; for example, combustion at high rating could frequently be improved by modifications which raised the pressure drop, but high pressure drop had an adverse effect on engine performance.

On the first batch the only means of development was to try the effect of modifications to actual engines, and a good deal of progress was made in this way. It became evident that modifications could be tried much more quickly on a full-scale rig test, and that such a rig test afforded better facilities for exploration of physical phenomena within the chamber. A rig was manufactured for full-scale combustion chamber tests at atmospheric pressure, incorporating a first-batch F2 compressor with electric drive to 3000 r.p.m. This rig when complete was sent to the R.A.E., as there was no suitable site for a rig of this size then available in the company's works. A similar rig, shown in Fig. 5, was made later, using a second-batch compressor, and this rig has ever since been in regular service for full-scale tests of annular chambers with atmospheric exhaust.

It was soon found that, although rig testing

* Institution of Mechanical Engineers, January 10th. Abstract.

† Chief Engineer, Gas Turbine Engineering Department, Metropolitan-Vickers Electrical Company, Ltd.

realised the expected advantages, the behaviour of a combustion chamber in a complete engine did not reproduce its behaviour on rig test. There are several causes of this discrepancy. They include the difference in fuel supply and atomisation conditions, the difference in absolute pressures, and the difference in velocity profile of the air presented by the compressor outlet at partial r.p.m. on rig test, as compared with the velocity profile at much higher r.p.m. in the engine. It would have been as difficult and expensive to operate a pressure rig with a full-size annular chamber as to operate the chamber in an engine. The second-batch F2 compressor absorbed 250 h.p. on the atmospheric rig, but would have required 5000 h.p. to drive it to full speed on a pressure rig. Annular chambers have therefore always had to be finally developed on complete engines, and the rate of development of annular chambers has been slower than that of flame tubes which can be pressure tested with small-capacity plant.

Flying experience with first-batch engines indicated that in flight the combustion chamber performance was better than on bench test. There was less distortion and much less carbon deposit.

The first trial of flame tubes, which was a failure, was made on a first-batch engine in which the flame tubes were arranged within an outer casing of standard annular dimensions. The next trial was made on the second-batch engine specially designed for flame-tube research. The flame tubes were arranged in an

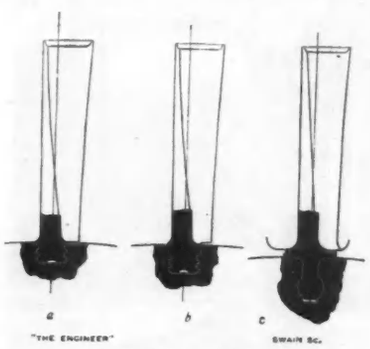


FIG. 6—*Turbine Moving Blade Root Fixing*

outer casing, 4½in larger in diameter than the standard annular casing, and several flame tube designs were tested with varying results. One flame tube chamber was ultimately developed to a point where it was better in outlet temperature distribution than any contemporary annular chamber, but it was inferior to the best annular chambers in specific consumption. No further tests were made on engines with flame tube combustion chambers. The flame tube cannot compete with the annular chamber in achieving the low frontal area possible with straight-through axial engines of the F2 type.

In the course of time many different types of annular combustion chamber have been tried on engines, each type usually undergoing minor modifications, first on the full-scale rig and then on an engine. It is apparent that with sufficient detail development quite a number of different types of chambers can reach a certain degree of success, one or two types showing far better all-round performance than others. Annular chamber development has now reached a stage on the third and fourth-batch engines, where the chamber is comparable in durability with the other components exposed to high temperature. There is still scope for rating up of the engine due to improvements in the combustion chamber.

There has been great experimental development in the technique of traversing for temperature, pressure, velocity and gas sampling. Curious recirculation and mixing phenomena have been brought to light. Gas analysis has been found necessary from the B10 development onwards, and a specialist chemical laboratory is operated for sampling combustion gases.

Much research has been directed towards elucidating the basic physical phenomena in combustion chambers, but it cannot be claimed that these phenomena are fully understood, or that the time is near at hand when combustion chambers can be designed from first principles. The research tests and the experimental development have, however, given an accumulated knowledge of relationships between cause and effect which enable successive developments to be carried out more intelligently than in the early days.

The fuel used in the B10 plant was "Pool" diesel. Most subsequent testing has been done on kerosene, as aviation kerosene is the standard fuel for R.A.F. gas turbines, although some tests have been carried out with other fuels, notably "Pool" gas oil. Combustion chambers already developed for one fuel sometimes give carbon deposit when run with a different type of fuel; but after development, when necessary, successful running has been obtained with each fuel tested.

Fuel jets and igniters have given little trouble in running since some early difficulties were overcome. There has, however, been continuous development in technical and manufacturing features. The type of fuel jet mainly used has been the solid-injection type with no moving parts or swirl-producing devices, spraying upstream against the backplate. The limits of permitted variation of flow quantity and flow pattern permissible with individual jets have been progressively tightened, and photographic research is in progress on fuel jet sprays. The type of igniter used in all but the earliest tests has been a sparking plug igniter to which a jet of priming oil is fed on starting. There are two igniters per engine, mounted in recesses with air circulation so arranged that the ignition flame is blown into the primary chamber to ignite the main jets, while, after ignition, the igniter is not exposed to flame.

The sheet metal used for combustion chambers throughout the development has been "Immaculate V," an austenitic steel which has been on the market for a number of years. This material is highly resistant to corrosion from products of combustion, but it is not easy to work or weld, although a specialist sheet-metal shop has done wonders with it. The combustion chamber flanges and fittings are of "F.D.P.," another commercial austenitic steel.

The distortion troubles which for a period afflicted combustion chamber development have been shown by experience to be associated with the design rather than with the material. Simplicity of construction, freedom from redundancy, suitability of cooling air circuits, and uniformity of combustion conditions all aid in ensuring freedom from distortion.

Turbines.—The background for turbine development was provided by the company's steam turbine experience. On the B10 turbine, however, it was decided, in consultation with the R.A.E., to try a blade section of low camber which departed from conventional steam turbine practice, and which owed something to aeronautics. Some preliminary cascade tests were carried out with sections of this type, using existing equipment for testing steam turbine blading, and a section was chosen for manufacture. The B10 turbine was rigged up with a dynamometer and tested on superheated steam.

In the B10 and later turbines, the blade sections were chosen to approximate to vortex flow at the designed operating condition. The term "vortex flow" was introduced through the R.A.E., but the principle was not new. Metropolitan-Vickers had years before made calculations on steam turbine blading with flow compensated for centrifugal force, and had used steam turbine blading design for partial compensation.

The F2 turbine blade sections were much closer to established steam turbine practice. The initial design, used on the first and second batches, was laid out and detailed without preliminary experimental work. The turbine blade sections were slightly changed on the third batch, not for aerodynamic reasons, but to give greater "swallowing" capacity and so to permit of cycle operation at higher temperature. The single-stage turbine design for the F2/4 was also close to established steam turbine practice. The F2 turbine performances have been satisfactory in service, and no rig tests have been made for turbine efficiency.

After F2/4 engines were in operation a series of tests was started in the high-speed wind tunnel on a cascade representing the turbine moving blade root section. The object of these tests was to explore flow over a wide range of incidence and Mach number. The tests showed peculiar variations in cascade properties with the Mach number, similar to variations which have previously been observed in steam turbine blade researches. The aerodynamic explanation of these phenomena is provided by shock waves which appear within the blade passage at a certain Mach number, and which move to positions outside the blade passage as the Mach number increases. This explanation was established theoretically, and was verified and elaborated by direct observations of flow in the wind tunnel by shadowgraph and Schlieren methods.

The most serious problems on turbines were mechanical rather than aerodynamic, and arose from the unprecedentedly high temperatures encountered. The company's previous experience of creep and creep testing was used in testing and selecting high-temperature materials. The material at first used for turbine blading was "Rex 78," an austenitic steel which had been specially developed for high-temperature service. It gave good service up to a certain temperature, and was far superior to any commercial steels available in 1939, but it was found that turbine fixed blading of "Rex 78" developed cracks on the outlet edge when ex-

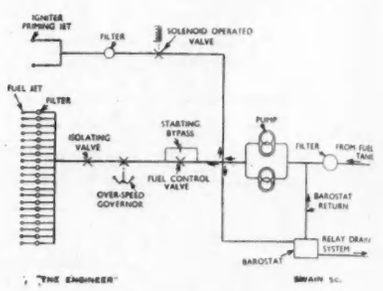


FIG. 7—*Diagrammatic Arrangement of the Fuel System*

posed to hot-spots. The cracks looked alarming, but no fixed blade has ever failed due to these cracks.

"Nimonic 75," a nickel-chromium alloy with properties resembling those of an austenitic steel, was developed later, and was tried as an alternative blading material on some first-batch engines. It proved somewhat more resistant to cracking than "Rex 78."

Rig tests on the cracking of test pieces representing blade edges under intermittent heating were carried out with a wide range of materials early in 1943. "Nimonic 80," recently developed for its good creep properties, proved more resistant to cracking than any other material with properties at high temperature otherwise suitable. When the third-batch engines were designed "Nimonic 80" was in short supply. It was therefore used for the fixed blading only and "Rex 78" was used for the moving blading. The higher temperatures on the third-batch engines quickly brought about moving blade failures, and the standard material was changed to "Nimonic 80," of which both fixed and moving blades were made on all the F2/4 engines. Some blading trouble due to local high temperatures was experienced in the development of the F2/4 engine, but this has been overcome by combustion chamber improvement.

On the turbine fixed blading provision is always made for permitting radial expansion, but maintaining concentricity. On the first-stage fixed blading of the first three batches, this provision took the form of an integral pin on each blade at the inside diameter, sliding in a radial hole in the supporting diaphragm. On the fourth batch, provision is made by projections on each blade at the outside diameter

which slide in splines. Both arrangements have been entirely satisfactory.

Axial root fixing has been used throughout for turbine moving blades. The development of this fixing is illustrated in Fig. 6. The shallow serrated root fixing *a* was used on the first batch. There were two instances of blade failure by fatigue in the root just below the active height of the blade. Two different designs were therefore tried in second and third-batch engines—serrations with a shank *b* and a bulb root fixing *c*. Arrangement *b* was successful, but fatigue failures were experienced with *c*. The standard arrangement adopted was therefore *b*. On F2/4 engines, where there is a heavier load on the root fixing, the original bulb root fixing has been changed to a serrated type.

The turbine disc material used at first was "Rex 78." Later experimental discs were tried in "Nimonic 75" and in "Moly-Van." All three materials have been completely successful. "Moly-Van" is a ferritic steel alloy containing molybdenum and vanadium. It was originally developed for high-temperature steam turbine discs. With disc cooling as applied on F2 engines, it has been found well suited to gas temperature conditions far severer than in steam practice. It is now the standard disc material, as it is cheaper and easier to work than the austenitic materials mentioned.

It is remarkable that, viewing the development as a whole, the high-temperature materials for the combustion chamber and the turbine have given less trouble than the light alloy materials for the compressor.

Fuel System.—The F2 fuel supply and control system presents its own problems as compared with systems for jet propulsion engines of different type, and systems developed for other engines have therefore required adaptations to the F2 engine. The experience of specialist accessory manufacturers has been drawn upon, and proprietary auxiliaries have been largely used in fuel systems. The main control valve has usually been of Metropolitan-Vickers design.

The development of Metropolitan-Vickers components and control systems has been very largely empirical, and has been carried out on rig test and on engine test, use being made of rig test as far as possible. Cinematographic recording has been used in developing control systems on engine test.

The fuel control systems used in all flight engines have been of the pressure-barostat type, in which the pressure of the fuel supplied through the throttle valve to the fuel jets is regulated by a relief valve which responds to atmospheric pressure. This is one method of ensuring an engine speed which is nearly independent of altitude for any fixed control lever setting. As an example of this system (Fig. 7), a description follows of the fuel system used on the first flight build of the F2/4 engine. Fuel supplied to the engine is passed through a filter, and is raised in pressure by gear pumps driven by the engine. The fuel pressure, after the pumps, is regulated by the barostat, in which a relay, operated by the fuel pressure itself, causes the relief valve setting to respond to an atmospheric capsule. A fuel connection to the igniter priming jets is controlled by a solenoid-operated valve, which opens when the igniters are switched on. The oil to the main fuel jets is regulated by the fuel control valve operated by the pilot's lever. Fuel from the main control valve passes through the overspeed governor valve; on overspeed, this valve throttles, but does not cut off the fuel supply, so that combustion is not extinguished. The fuel then passes through a separate isolating valve to the manifold, which distributes fuel to the twenty fuel jets.

Bench tests have also been made with fundamentally different systems. These include a flow control barostat system and an all-speed governor system.

In the early stages of F2 development, a good deal of work was done on control valves incorporating relay devices to limit the rate of building up of the fuel supply, in order to prevent stalling and overheating troubles. After a time these relay valves were abandoned, as adequate and more consistent results were obtained with positively operated control valves. In recent months there has been a return to the relay-operated control valve, which limits acceleration, since the necessity for lower idling thrust leads to a smaller margin against stalling in acceleration from idling speed on ground running.

Serious problems are presented by the wide range in fuel quantity to be handled between starting and high-altitude idling conditions, on the one hand, and full-speed sea-level conditions, on the other. With the plain fuel jets used, flow across each jet is proportional to the square root of the pressure difference, so that a very large range of pressure difference is desired. The pressure difference across the fuel jet is limited at the lower end of the range by atomisation and distribution considerations, and at the upper end by the pressure which the fuel pump can conveniently supply. Some work was done on a duplex fuel system in which the fuel jets were divided into two groups, one group only being used for low fuel flows. It was found that considerable complication was necessary to obtain automatic and smooth transition between one-group and two-group operation, and the duplex system was abandoned, as satisfactory performance was ultimately obtained with a single group.

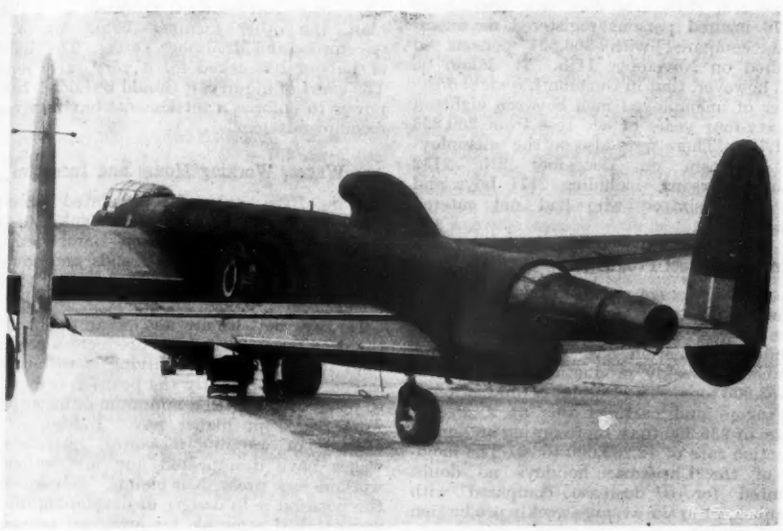


FIG. 8—"*Lancaster*" *Flying Test Bed*

Flight Testing

Flight testing of aircraft is not within the scope of this paper, but the F2 engines have been extensively tested in flying test beds, and some reference to this work is appropriate.

The first flight of an F2 engine took place in a "Lancaster" flying test bed. The engine was mounted in the tail of the "Lancaster," which retained its normal main engines and propellers. The first series of flight tests provided useful mechanical and operational experience, but little in the way of reliable performance information, and it was difficult to co-ordinate the observations with bench tests on the engine. Deficiencies in the instrumentation brought to light were rectified in later series of tests.

In 1944 the same F2 engine was removed to another "Lancaster" flying test bed, in which an automatic observer had been provided. This, giving camera recording of the test gauges, proved a great advance. Immediately before installation the engine was bench tested, using the same automatic observer in parallel with the normal test gauges. In flight an excellent and comprehensive series of overall performance tests were obtained, covering a considerable range of altitude, flight speed, and engine speed. This series of tests generally confirmed the performance of the F2 engine predicted from bench tests, excepting that the fuel consumption at altitude was a little above the expected figure.

The flying test bed was at first operated by the R.A.E. from Farnborough. In August, 1944, responsibility for the flight testing was taken over by Power Jets (Research and Development), Ltd., and flying since that date has been carried out from aerodromes in the Midlands. Fig. 8 shows a flying test bed with the engine mounted in the tail.

The flying test bed is a useful piece of equipment, providing important results which cannot be obtained on bench test, and which are inconvenient to obtain on a standard jet-propelled aircraft. It does not attain the full range of altitudes and flight speeds met with on jet-propelled aircraft, but it is, however, a source of most aggravating delay and waste of time, due to aircraft troubles, main engine troubles, and weather conditions. An alternative to the flying test bed, not subject to these delays, is the high-altitude test plant. There is no high-altitude test plant for jet engines in this country, and the cost of such a plant is too high to be faced by each individual manufacturer. The author regards the provision of a national high-altitude test plant as an urgent matter.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The prices of each specification is 2s. 3d. post free, unless otherwise stated.

ELECTRIC DISCHARGE LAMPS FOR GENERAL PURPOSES

No. 1270 : 1946. In 1945 the British Standards Institution issued a schedule of dimensions for various types of electric discharge lamps, including mercury, mercury fluorescent, mercury dual, mercury tubular fluorescent, and sodium types. A new edition of this schedule, including figures for the nominal efficiencies and life of the lamps, has now been issued as B.S. 1270 : 1946. The efficiency and life values quoted are estimates of the minimum average values for the lamps at present available.

AIR-DEPOLARISED PRIMARY CELLS

No. 1335 : 1946. This specification prescribes the minimum rating of air-depolarised type primary cells on continuous discharge and gives the methods of test on which the rating is based. A system of nomenclature is prescribed by which the type and size of cell are expressed by a sequence of two or three letters and a number. Details of the quality of materials to be used, and also dimensions of electrodes, containers, connecting wires and terminals are also given.

Industrial and Labour Notes

Industrial Negotiations and Wages Policy

When the House of Commons re-assembled on Tuesday last, the Prime Minister was asked if he would consider the setting up of a Select Committee to examine existing negotiating machinery with a view to seeing how the working of such machinery could be speeded up. He was also asked if he would consider the appointment of a Royal Commission to investigate trade union structure.

In reply, the Prime Minister said that consideration could not be given to these suggestions. It was, and should remain, the primary responsibility of both sides of industry to ensure that the nature of their organisation and the operation of any joint voluntary machinery to which they might be parties were such as to ensure the prompt and effective consideration and settlement of problems as they arose. The adequacy of the existing arrangements for the determination of claims relating to conditions of employment and the settlement of disputes was, however, being examined by the Government.

The Prime Minister was also asked whether he was now in a position to define the Government's wages and salaries policy. In reply to this, the Prime Minister reiterated that Government policy was that responsibility for wage regulation should, in general, continue to be exercised through the machinery of joint voluntary negotiation. In conformity with this policy, the Government had issued a full statement of the economic considerations affecting relations between employers and workpeople which was designed to assist both sides of industry in assessing the full nature of their responsibilities in the light of the economic situation of the country as a whole. The Prime Minister added that the general responsibility for wages policy rested with the Minister of Labour and National Service.

British Overseas Trade

The Board of Trade Accounts, issued on Tuesday evening last, show that the value of exports of United Kingdom goods in the month of December was £82,895,959, compared with £92,096,893 in November. The decline was generally expected in view of the shorter number of working days caused by the Christmas holiday. Imports in December were valued at £117,011,776, and re-exports totalled £5,195,769.

With the publication of the figures for December, it is possible to give an approximate total for exports and imports during the whole of 1946. The value of exports of United Kingdom goods was £911,686,238, compared with £399,275,982 in 1945 and £470,755,320 in 1938. Imports during 1946 amounted in value to £1,297,682,580, compared with £1,103,693,217 in 1945 and £919,508,938 in 1938. The high value of exports, compared with pre-war years, was caused entirely by increased prices, and according to estimates made by the Board of Trade, the actual volume of goods exported from the United Kingdom during last year was about the same as that recorded for 1938.

Employment and Unemployment

The Ministry of Labour's latest figures regarding employment in Great Britain indicate that in the month of November, 1946, the total working population was 20,324,000. During that month there was a decrease of 43,000 in the number of men in the working population, but the number of women increased by 14,000. At the end of November, however, the total working population was greater than at mid-1939 by 574,000 (152,000 fewer men and 726,000 more women).

The total number of people employed in industry in November last was 18,015,000 (12,394,000 men and 5,621,000 women), which was 98,000 above the figure recorded in the preceding month and 95,000 above the mid-1939 figure. The number of those engaged in the manufacture of equipment and supplies for the Forces was again reduced in November and at the end of the month was 474,000, compared with 1,270,000 at mid-1939. There were 17,541,000 people employed in home civilian industries and services and manufacture for export at the end of November, a figure 891,000 above that recorded at mid-1939, and approximately 600,000 above the normal pre-war level. Analysis of the manufacturing industries shows that in November there were 5,040,000 people engaged in the production of goods for the home market and 1,440,000 engaged in manufacturing for export. The mid-1939 figure for the latter group was 990,000. It is of particular interest to note that in the group of industries classified as metals and chemicals—which includes shipbuilding and engineering—there were 915,000 people employed in November on manufacture for export, compared with 450,000 at mid-1939.

The latest unemployment figures relate to December 9, 1946, on which date there were 362,976 insured persons registered as unemployed, compared with 366,531 persons so registered on November 11th. It should be noted, however, that in the month reviewed the number of unemployed men between eighteen and sixty-four years of age rose from 260,296 to 261,729. There were also on the unemployment registers on December 9th 7132 uninsured persons, including 2171 boys and girls under sixteen who had not entered industry.

Iron and Steel Production

The average weekly production of pig iron in the United Kingdom in the month of December was 153,200 tons, which represented an annual production rate of 7,966,000 tons. The average weekly production in November was 153,900 tons. The December production of steel ingots and castings was at a weekly average of 236,300 tons, representing an annual production rate of 12,289,000 tons. The incidence of the Christmas holidays no doubt accounted for a decrease compared with November, when the average weekly production was 263,800 tons.

Output figures for the whole of the year 1946, issued by the British Iron and Steel Federation, reveal that pig iron production totalled 7,761,000 tons, compared with 7,107,000 tons in 1945, and that steel production amounted to 12,693,000 tons, compared with 11,824,000 tons in 1945 and 10,398,000 tons in 1938. Last year's steel output therefore very nearly approached the target of 12,750,000 tons, in spite of fuel and transport difficulties with which the industry was faced.

Polish Miners

The National Union of Mineworkers stated last week that, following a discussion with representatives of the Trades Union Congress, it was now prepared to agree to the proposal that Polish ex-Service men should be employed in the coal mines. The National Union made it clear, however, that Poles should only be employed if the particular miners' branch or lodge concerned approved, that they should join the miners' union, and that they should be the first to be discharged in the event of redundancy.

This agreement will not make much difference to the present labour force of the mines, as it is estimated that the number of Polish ex-miners available for work immediately is not more than 170.

The Road Haulage Workers' Claim

Road haulage workers in London and other places who had been on strike since January 6th returned to work on Saturday last, and on Sunday the newly appointed National Joint Industrial Council met to consider the claim regarding hours, wages and working conditions put forward by the Transport and General Workers' Union. The claim relates to a 44-hour week, with wages in the various classifications to be the same as those now paid for a 48-hour week, and also a regulated working week of five or five and a half days.

Following last Sunday's meeting, the Ministry of Labour stated that the National Joint Industrial Council for the Road Haulage Industry had been unable to reach agreement on the trade union claim. Subsequently, the Minister of Labour had joined the meeting and the matter had been further discussed. Having regard to the divergence of view and to the importance of the issues involved, the Minister had informed the Council that he had decided to refer the matters in dispute to a court of inquiry under the Industrial Courts Act, 1919. The appointment of the court of inquiry was announced on Monday last. Lord Terrington, a member of the National Arbitration Tribunal, is the Chairman, the other members being Mr. J. E. Greenwood and Mr. James Young. The Minister of Labour has asked for a very early report. The court of inquiry, it should be added, has no power to enforce a settlement, but may make recommendations.

Wages, Working Hours and Incentive

In a statement circulated with the annual accounts of the District Bank, Ltd., the chairman, Sir Robert Noton Barclay, makes some comments on wage trends and working hours and their relation to the country's industrial productivity.

He says that we are not left in doubt about the need for an increase in production per man-hour if our standard of living is to be maintained, but apparently the position is expected to resolve itself with a minimum of incentive to workers except higher pay. Indeed, in the absence of wartime measures, restraints on wages have disappeared and all sections of workers now press their claims. Consequently, the position is in danger of developing into an uncontrolled scramble for increased remuneration conducive to an ominously rising spiral of wages, costs and prices. To this extent, Sir Robert observes, our economic policy, because it fails to include wages, is not only incomplete, but is also clearly inflationary. Furthermore, it is not limited to attracting labour by increasing wages, but also aims at the reduction of working hours.

It may be argued, the statement continues, that all this should be done in the cause of incentive, but unless maximum reward is coupled with maximum effort may not incentive be destroyed and with it the active healthy life of the community? Actually, Sir Robert asserts, we are already committed to an experiment whereby wages are raised in the hope that increased productivity will follow, but while high wages, short hours and good holidays are all beneficial in themselves, they should not be placed before output.

Control of Iron and Steel Order

The Minister of Supply has made the Control of Iron and Steel (No. 56) Order, which provides for increases in the prices of steel castings, chain link fencing and mattress wire. The Order, which came into force on January 21st, may be obtained from H.M. Stationery Office, price one penny.

The related schedules, Nos. 143 to 148, inclusive, lodged under the Order, may be inspected at Steel House, Tothill Street, S.W.1, and at the Birmingham, Manchester, Sheffield, Newcastle, Glasgow and Belfast regional control offices of the Ministry of Supply.

French Engineering News

(From our French Correspondent)

PARIS, January 17th.

During the next ten years, the S.N.C.F. is to push forward with its electrification programme, partly for the technical advantages it will bring, and also to secure economy in the use of coal. By 1955, a total of 5605 km will be electrified, of which 394 km will be suburban lines. Annual power consumption will be 1900 million kWh with a total saving of 2,700,000 tons of fuel, or 480 tons per kilometre electrified. By 1955 France will have 1507 electric locomotives.

The S.N.C.F. has decided to retain the 15,000 volt d.c. system, in spite of advantages offered by the 5000 volt single-phase and the 3000 volt direct system. It is considered that the co-existence of two systems would seriously hamper development of main lines. However, it is possible that a more economical system may be used for the electrification of secondary lines. For fast passenger trains, 5000 h.p. locomotives with a speed limit of 140 kilometres an hour will be used. Goods locomotives of 2400 h.p. will draw 750-ton trains at 105 kilometres an hour, and goods trains of 1300 tons at 85 kilometres an hour. Small quantities of other locomotives intended for special purposes, such as mountain operation and locomotives for very high speed trains will also be constructed. Passenger coaches will be modernised, but this is expected to take 15 years. Three types of railcars have been retained; light 150 h.p. railcars with 80 seats, for speeds up to 90 kilometres an hour; 300 h.p. railcars with 100 seats, for speeds up to 120 kilometres an hour; and two-engined, 600 h.p. railcars. Types of goods trucks have also been rationalised and largely reduced.

Rolling stock constructors are asking that they should be allowed more generous allocations of materials so that they can play a larger part in supplying necessary orders, rather than have orders placed abroad, which weigh heavily on the country's financial equilibrium, while leaving French manufacturers insufficiently occupied. Already there has been an improvement following the allocation of 25,000 tons of steel for rolling stock, and it is suggested that it would be worth while importing iron and steel, if necessary, rather than finished products, to assure maximum activity to French workers.

* * *

The Centre Technique du Machinisme Agricole recently met to discuss the types of fuel used by tractors. Two sub-commissions were appointed, one presided over by Monsieur Lemaigre, of the Etablissement Latil, the other by Monsieur Passelegue of the Etablissement Bernard Moteurs. An enquiry was also held into threshers and reapers used in France, and some interesting conclusions were drawn on standardisation and also on the width of tracks for tractors. Two new services have also been started to deal with dairy machinery, and rationalisation of modern machine tools.

* * *

The Moroccan hydro-electric plant at Imfoute will be equipped with two 15,000 kW machinery groups, one of which will come into service during 1947, the other during 1948. The height of the falls is 37 metres, and the flow will reach 50 cubic metres. Two lines have been planned, one of 150,000 volts, linking with the general network by three single-phase transformers, each of 13,500 kW, the other, of 60,000 volts, with a possible output of 18,000 kW, joining the electrified railway line from Marrakech to Casablanca, which runs near the power station.

* * *

The pipe lines Tarbes to Pau and Tarbes to Pierrefitte, which will shortly come into service, and a second pipe line, diameter 313 mm, pressure 60 kg, Peyrouzet to Toulouse, will greatly increase the gas drawn off from Saint Marcet. The Petrol Régie recently ordered from the United States a new installation capable of treating 1,200,000 cubic metres of gas a day, and the new unit will be placed either at Peyrouzet or at Boissens.

Notes and Memoranda

Rail and Road

CHINESE RAILWAY DEVELOPMENT.—The Chinese Ministry of Communications has announced a plan for the construction of an 1800 mile railway, linking Lanchow, provincial capital of Kansu, in north-west China, with Kwangchowan, in south-west China. The line is to go through Tienshui in Kansu, Kwangyuan in Szechwan, Kweiyang in Kweichow, and Liuchow in Kwangsi. The Lanchow-Tienshui section is reported already to be under construction. Meanwhile, repairs to the Kweilin-Liuchow section of the Hunan-Kwangsi-Kweichow Railway, which was damaged during the war, have been completed. Following successful trial runs, held on January 6th, it was decided that the traffic section should be resumed on January 20th.

BRUNEL'S WOODEN VIADUCTS.—The last two timber viaducts on the Great Western Railway system, Dare and Gamlyn, designed by I. K. Brunel, are now being dismantled. They are 450ft and 600ft long, respectively, by 70ft in height, and were constructed to carry the Dare Branch over deep valleys near Aberdare, when the line was opened in 1855. The closing of this branch line rendered the viaducts redundant. The dismantling is being carried out by a gang of seven men using a steam crane and hand winches. Some 25,000 cubic feet of valuable timber will be salvaged and made available for use as shuttering, piling, footbridges, joinery work and for laying a new floor in a carriage and wagon repair shop at Pontypool Road.

AMERICAN RAILWAYS IN 1946.—A recent statement by Mr. R. V. Fletcher, president of the Association of American Railroads, said that although the railways of the U.S.A. handled during 1946 a greater volume of traffic than in any other peacetime year, their net earnings were little better than in the years of depression preceding the second world war. Because of sharply increased wage rates and prices of fuel and supplies, the margin between railway expenditure and revenue in 1946 was, Mr. Fletcher claimed, the smallest since 1920. Referring to equipment needs, Mr. Fletcher commented that some improvement in supplies had taken place since the end of the war, but shortages of materials and labour difficulties had slowed down deliveries of essential equipment.

Air and Water

PARIS-LONDON RECORD FLIGHT.—On January 16th, a new record for the air journey from Paris to London was set up by Squadron-Leader W. A. Waterton, flying a Gloster "Meteor IV." The time taken for the 218 miles from Le Bourget to Croydon was twenty minutes eleven seconds.

CIVIL AVIATION IN U.S.A.—Statistics relating to civil aviation in the U.S.A. during 1946 show that the number of registered aircraft increased during the year from 38,000 to 85,000, and the number of certified pilots from 296,000 to 400,000. Passengers carried on the various airlines numbered over 13,800,000. Passenger fatalities in 1946 were 1·47 per 100,000,000 passenger miles flown, compared with 2·31 in 1945.

COMPANY OF SHIPWRIGHTS' EXHIBITION.—The Company of Shipwrights' Exhibition will be opened at the Royal Horticultural Hall, Westminster, S.W.1, on Tuesday next, January 28th, and will remain open until February 8th. It has been organised by the Worshipful Company of Shipwrights, and will demonstrate the traditional skill of British shipbuilders, showing how it has been enhanced by the amount of technical progress made in recent years.

CHINA'S SHIPPING TONNAGE.—The tonnage of China's merchant fleet is to be increased by 159 American surplus vessels aggregating about 800,000 tons, according to a report of the Shanghai Steamship Companies. It is also learnt that certain Chinese lines are contemplating an expansion of their services to foreign countries, especially those in the South Seas area. According to Chinese customs figures recently released, British and American ships entering Chinese ports in October totalled 144,743 and 134,313 tons respectively. The British tonnage was a slight improvement over the September position, while the American figure represented a drop of 35 per cent. The major Chinese shipping firms have formed a joint salvaging concern to raise the thirty-seven ships sunk by the Japanese during the war in various parts of the Whangpoo River.

Miscellanea

I.M.E.A. CONVENTION.—The Incorporated Municipal Electrical Association's Convention is to be held at Bournemouth, from June 23rd to June 27th, inclusive.

KING'S COLLEGE ENGINEERING SOCIETY.—The King's College, London, Engineering Society is to celebrate the centenary of its foundation from March 5 to 8, 1947. All "King's Engineers" are invited to apply for details of the celebrations to the Hon. Secretary of the Engineering Society, King's College, London, W.C.2.

AMERICAN COAL PRODUCTION.—Production of soft coal in the U.S.A. in 1946, up to December 21st, amounted to approximately 514,607,000 tons, a decrease of 9·5 per cent, compared with the corresponding period of 1945. The output of hard coal in the same period of 1946 was about 59,488,000 tons, or 9·9 per cent more than in the preceding year.

INDUSTRIAL CO-PARTNERSHIP.—The Industrial Co-Partnership Association will hold a buffet-luncheon in the Assembly Hall of the Royal Empire Society, Northumberland Avenue, W.C.2, on Tuesday, January 28th, at 12.30 p.m. At 1.15 p.m., Sir Godfrey Ince, Permanent Secretary of the Ministry of Labour, will give an address entitled "Manpower—Co-operation between Government and Industry." Tickets for the luncheon, 3s. each, may be obtained from the Industrial Co-Partnership Association, 36, Victoria Street, S.W.1.

DONCASTER ENGINEERING EXHIBITION.—The Doncaster Engineering Society is to hold its second exhibition of the "Products of Engineering made in Doncaster," from February 15th to February 22nd, inclusive. The Exhibition will take place in the Doncaster Technical College Hall, and about twenty firms are participating along with the Doncaster Model Engineering Society. The aim is to bring to the notice of the general public the diversity and character of the engineering work carried on in Doncaster and district. Admission is free and a descriptive brochure will be available at a small charge.

STANDING TIMBER PRICES.—Strong representations have been made to the Board of Trade that the maximum prices for standing timber, which were fixed by an Order at the outbreak of war and have not been changed since, should be increased to cover increased costs of maintenance and replanting. The Board of Trade now announces that after full consideration it has made an Order which provides increased maximum prices for standing timber. The Order came into force on January 2nd and authorises an increase of 25 per cent in the maximum prices of growing trees sold for felling and appropriate higher maximum prices for home-grown timber in the log. The adjustments corresponding to the increased maximum prices of growing trees are to be incorporated in revised maximum prices of home-grown mining timber and home-grown converted timber. It is expected that they will be published and brought into force within the next month.

ELECTRIC TRACTION JUBILEE.—A brief history of fifty years of electric traction with some account of the part played by the British Thomson-Houston Company, Ltd., is contained in an interesting book, "Electric Traction Jubilee, 1896–1946," by J. H. Cansdale, M.I.E.E., A.M.I.Loco.E. This profusely illustrated book traces the development of electric traction from 1883, when Magnus Volks' miniature electric railway at Brighton and the Giants' Causeway and Portrush Railway in Northern Ireland were opened to the public. In describing the development of the d.c. traction motor for tramcars and trolleybuses, the author makes graphic use of line diagrams to illustrate various stages in the progress towards cleaner and more compact designs. Many will find the chapter "Tramways Have Their Day" less provocative than its title, for the author concedes that for certain classes of service the tramcar is "still the most efficient vehicle . . ." The author describes with numerous examples the growth of railway electrification, the coming into favour of the trolleybus, the history of battery-operated vehicles on road and rail, and the place of electric locomotives in industry. Many of the illustrations are of unusual historical interest. Two examples will suffice to show the extent of the author's researches: The first depicts one of the early City and South London electric locomotives, with its name plate dated 1889; the second shows a 1909 electric landaulette taxi, fitted with B.T.H. hub motors.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Tuesday, Jan. 28th.—MANCHESTER BRANCH: Reynolds Hall, College of Technology, Manchester. "Fuel Efficiency in the Chemical Industry," A. C. Dunningham. 3 p.m.

Bradford Engineering Society

Monday, Feb. 3rd.—Technical College, Bradford. "Air Conditioning," F. C. Frean. 7.15 p.m.

British Interplanetary Society

Saturday, Feb. 1st.—St. Martin's Technical School, Charing Cross Road, W.C.2. "Interplanetary Flight: Is the Rocket the Only Answer?" A. V. Cleaver. 6 p.m.

Chemical Society

Thursday, Jan. 30th.—SHEFFIELD BRANCH: The University, Sheffield. "Some Relationships Between the Structure and Properties of Natural and Synthetic Fibres." J. B. Speakman. 5.30 p.m.

Institute of Marine Engineers

Monday, Feb. 3rd.—SUNDERLAND JUNIOR SECTION: Technical College, Sunderland. "Combustion Turbines," J. Calderwood. 4 p.m.

Institute of Physics

Saturday, Feb. 1st.—S. WALES BRANCH: University College, Cardiff. "Some Applications of Calculating Machines," J. Comrie. 3 p.m.

Institute of Welding

Wednesday, Jan. 29th.—Inst. of Civil Engineers, Great George Street, S.W.1. Discussion, "Future Ships—Will they be All-Welded?" 6 p.m.

Institution of Automobile Engineers

Tuesday, Jan. 28th.—BIRMINGHAM BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "The Road Manners of the Modern Car," Maurice Olley. 6.30 p.m.

Thursday, Jan. 30th.—DERBY BRANCH: School of Arts, Green Lane, Derby. "Some Problems of Cylinder Bore Wear," W. A. Robotham. 7 p.m.

Institution of Civil Engineers

Tuesday, Jan. 28th.—Great George Street, S.W.1. "Meanders and their Bearing on River Training," Sir Claude Inglis. 5.30 p.m.

Friday, Jan. 31st.—YORKSHIRE ASSOCIATION: Great Northern Station Hotel, Leeds. Twenty-sixth annual dinner. 7 p.m.

Institution of Electrical Engineers

To-day, Jan. 24th.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2. "The Application of Electrical Technique to the Service of Some Other Industries," H. Cobden Turner and G. M. Tomlin. 5.30 p.m.

Monday, Jan. 27th.—N. EASTERN CENTRE: Neville Hall, Newcastle-on-Tyne. "Lightning Surges on Transmission Lines in Ireland," R. C. Cuffe. 6.15 p.m.

Tuesday, Jan. 28th.—N. MIDLAND CENTRE (INSTALLATIONS GROUP): Corporation Electricity Department, Whitehall Road, Leeds. "Engineering Principles Applied to the Design of Domestic Water Heating Installations of the Solid Fuel Electric Type," R. Grierson and Forbes Jackson. 6 p.m.

Wednesday, Jan. 29th.—SCOTTISH CENTRE: Heriot-Watt College, Edinburgh. "The Analysis of Vibration Problems," A. J. King. 6 p.m.

Thursday, Jan. 30th.—Savoy Place, Victoria Embankment, W.C.2. "The Teaching of the Principles of Electrical Machine Design," L. H. A. Carr. 5.30 p.m.

Monday, Feb. 3rd.—S. MIDLAND CENTRE: James Watt Institute, Great Charles Street, Birmingham. "Engineering Principles Applied to the Design of Domestic Water Heating Installations," R. Grierson and Forbes Jackson. 6 p.m. — N. EASTERN CENTRE (RADIO AND MEASUREMENTS GROUP): King's College, Newcastle-on-Tyne. "A Method of Transmitting Sound in the Vision Carrier of a Television System," D. I. Lawson. 6.15 p.m.

Monday, Feb. 10th.—N. EASTERN CENTRE: Neville Hall, Newcastle-on-Tyne. "Growing Importance of Plastics in the Electrical Industry," G. E. Haefely. 6.15 p.m.

Institution of Factory Managers

Saturday, Jan. 25th.—Waldorf Hotel, Aldwych, W.C.2. Annual general meeting. 2.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 24th.—Storey's Gate, St. James's Park, S.W.1. "Materials New to Engineering," F. T. Barwell. 5.30 p.m.

Saturday, Jan. 25th.—GRADUATES SECTION: Storey's Gate, St. James's Park, S.W.1. "Coal Mining and the Mechanical Engineer," W. J. Drummond. 3 p.m.

Wednesday, Jan. 29th.—WESTERN BRANCH: Merchant Venturers' Technical College, Unity Street, Bristol. Presidential Address, O. V. S. Bulleid. 6.30 p.m.

Friday, Jan. 31st.—Storey's Gate, St. James's Park, S.W.1. "The Life of Carbide-Tipped Turning Tools," F. F. P. Bisacre and G. H. Bisacre. 5.30 p.m.

Saturday, Feb. 1st.—YORKSHIRE GRADUATES: Midland Hotel, Bradford. "Heat Treatment," A. D. G. Fitzjohn. 2.30 p.m.

Monday, Feb. 3rd.—N. EASTERN BRANCH: Neville Hall, Westgate Road, Newcastle-on-Tyne. "Mechanical Engineering and Agriculture," S. J. Wright. 6 p.m.

Institution of Production Engineers

Friday, Jan. 31st.—E. COUNTIES SECTION: Lecture Hall, Electric House, Ipswich. "Production Methods as Applied to Machine Tools," T. P. N. Burness. 7.15 p.m.—LINCOLN SUB-SECTION: Technical College, Lincoln. "Education and the Apprentice," E. R. Walter. 6.30 p.m.

Monday, Feb. 3rd.—YORKSHIRE SECTION: Assembly Hall, Grammar School, Keighley. "Production Engineering Research," D. F. Galloway. 7 p.m.—COVENTRY GRADUATES: Technical College, Coventry. Discussion, "The Ideal Training for a Production Engineer." 7 p.m.

Junior Institution of Engineers

Saturday, Feb. 1st.—N. WESTERN SECTION: Geographical Society, 16, St. Mary's Parsonage, Manchester. "Town Planning from the Engineers' Aspect," E. L. Leeming. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Jan. 31st.—Mining Institute, Newcastle-on-Tyne. "Marine Gas Turbine," Dr. Ad. Meyer. 6 p.m.

North of England Institute of Mining and Mechanical Engineers

Saturday, Jan. 25th.—ASSOCIATES' AND STUDENTS' SECTION: Neville Hall, Newcastle-on-Tyne. "Recent Developments in Mine Lighting," W. B. Bell: and "Organisation of Colliery Maintenance," J. E. Marr. 2.30 p.m.

Royal Aeronautical Society

Thursday, Jan 30th.—Inst. of Civil Engineers, Great George Street, S.W.1. "Wartime Developments in Air Transport," Sir Ralph Cochrane. 6 p.m.

Royal Institution of Chartered Surveyors

Monday, Feb. 3rd.—12, Great George Street, S.W.1. "Professional Education," S. J. Worsley. 5.30 p.m.

Royal Institution of Great Britain

To-day, Jan. 24th.—21, Albemarle Street, W.1. "Milton and his Academic Exercises," J. T. Sheppard. 9 p.m.

Friday, Jan. 31st.—21, Albemarle Street, W.1. "Thin Films on Water," E. K. Rideal. 9 p.m.

Royal Statistical Society

Friday, Jan. 31st.—INDUSTRIAL APPLICATIONS SECTION: E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Control Charts Applied to Sales Data," B. P. Pudding. 6 p.m.

Sheffield Metallurgical Association

Tuesday, Jan. 28th.—The University, St. George's Square, Sheffield. "Some Aspects Other than Metallurgical of the Iron and Steel Industry," F. Pickworth. 6.30 p.m.

Tuesday, Feb. 11th.—198, West Street, Sheffield. "Trends in Furnace Design," H. Southern. 6.30 p.m.

Stephenson Locomotive Society

Saturday, Feb. 1st.—GLASGOW SECTION: Royal Technical College, Glasgow. "American Locomotive Practice," R. C. Menzies. 7.30 p.m.

Reports on German Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
B.I.O.S.:			
680	Manufacture of Caustic Soda, Chlorine and H.C.L.: I.G. Farbenfabrik Wolfen	4	2
681	German Cold Rolled Strip Industry	7	8
702	Interview with Dr. Roelig of the I.G. Rubber Service Laboratories, Leverkusen: Design of Rubber Parts to be Used in Engineering	0	7
711	Interrogation of Dr. Hans-Albrecht Kind, of Boehme Fettchemie and Henkel and Cie., Duesseldorf, Duesseldorf: German Laundry Industry, Information on Training, Research and Washing Components ...	7	2
F.I.A.T.:			
272	Telefunken A.G., Dachau, Germany, C. H. F. Mueller A.G., Fuhlsbuettel, Hamburg: Interrogations Regarding High-Frequency Communication Systems for Army Use, X-Ray Apparatus, &c.	1	1

During the past few months amendments and addenda to the following reports have been issued and made available at H.M. Stationery Office sales offices:—C.I.O.S. Nos. XXVIII-18, XXXIII-23; B.I.O.S. Nos. 35, 135, 199, 217, 307, 340, 345, 363, 405, 422, 423, 429, 438, 450, 468, 507, 572, 591, 773; F.I.A.T. No. 273.

An almost complete set of German patent specifications, accepted by the Berlin Patent Office during the war, has been secured for the United Kingdom. The specifications, for which either annual or weekly subject-matter and name indices are available, can be seen by the public at the Patent Office Library, 25, Southampton Buildings, Chancery Lane, W.C.2. Both the indices and the specifications are in German. Photographic copies of any specification and drawings may be obtained at the rate of 6d. per page.

Personal and Business

COMMANDER J. M. KEENE-MILLER has been appointed managing-director of Channel Islands Airways.

MR. K. C. LEE and MR. P. A. LEE have been appointed to the board of directors of Arthur Lee and Sons, Ltd.

SIR JOHN N. KENNEDY and MR. P. B. TUCKER have been appointed directors of Cowans Sheldon and Co., Ltd.

MR. STEPHEN L. FINCH. has been appointed foundry manager of Catton and Co., Ltd., Hunslet, Leeds.

THOMAS W. WARD, LTD., has acquired for dismantling the plant and equipment of the Hull Forge Iron and Steel Company, Ltd.

THE FORD MOTOR COMPANY, LTD., has acquired the entire share capital of the Kelsey-Hayes Wheel Company, Ltd., Dagenham, Essex.

R. C. HOPKINS, LTD., Birmingham, has opened a demonstration workshop and showroom at 323, Grays Inn Road, London, W.C.1. (Telephone, Terminus 4098.)

MR. STANLEY ROBSON has been appointed consultant to the Imperial Smelting Corporation, Ltd., the Zinc Corporation, Ltd., and New Broken Hill Consolidated, Ltd.

WILD-BARFIELD ELECTRIC FURNACES, LTD., has moved its Birmingham office and service depot to 21, Steelhouse Lane, Birmingham, 4. (Telephone, Central 6372).

MR. F. M. BURRELL, M.I.Mech.E., M.I.E.E., has retired from his position as engineer and manager of the Jersey Electricity Company, Ltd. Mr. H. H. Longson, M.I.Mech.E., A.M.I.E.E., has been appointed to succeed him.

COLONEL SIR W. CHARLES WRIGHT has expressed a wish to retire from the chairmanship of Guest, Keen, Baldwins Iron and Steel Company, Ltd. He will remain a director, and is to be succeeded as chairman by Mr. J. H. Jolly.

THOS. W. WARD, LTD., has purchased the whole of the share capital of Birchley Rolling Mills, Ltd., Oldbury. The company will continue to operate under its present name, with Mr. H. W. Secker as chairman and managing director.

MR. H. E. SLAWSON, M.I.P.E., has resigned from his position as Brown and Sharpe specialist to Buck and Hickman, Ltd. He will continue to serve as managing director of the Melbourne Engineering Company (Melbourne) Ltd.

THE COLONIAL OFFICE announces the following appointments: Lieut.-Colonel T. Mitchell, executive engineer, Public Works Department, Trinidad, and Major R. H. B. Johnson, assistant to the senior resident engineer, Trinidad Water Scheme.

MR. A. H. BARKER, M.Inst.C.E., announces that Mr. H. E. Baker, M.I.E.E., has entered into partnership with him. Their joint practice as consulting mechanical and electrical engineers will be carried on under the style of A. H. Barker and Partners, at 100, Victoria Street, London, S.W.1. (Telephone, Victoria 2688.)

MR. D. C. COLEMAN is retiring from his position as chairman and president of the Canadian Pacific Railway Company on February 1st. He will continue to serve on the Board. Mr. W. M. Neal has been elected chairman and president, and Mr. G. A. Walker, vice-president. Mr. William Manson has been appointed vice-president in charge of all C.P. railway services, and communications with headquarters in Montreal.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, LTD., announces an agreement with New Union Goldfields, Johannesburg, and Brush (South Africa), Ltd., under which the latter acquires the right to manufacture under royalty the products of the parent company. As a first step, it is proposed to undertake in South Africa the manufacture of Petter petrol-paraffin air and water cooled engines and small Brush transformers.

Contracts

THE LONDON, MIDLAND AND SCOTTISH RAILWAY has placed contracts with Wellerman Bros., Ltd., Sheffield, for the foundation for a new 60ft diameter turntable at Bransty Station, Whitehaven; L. Fairclough, Ltd., Adlington, Lancs, for excavations at Coleham Motive Power Depot, Shrewsbury, in connection with refuelling facilities for oil-burning locomotives, and in connection with a new 70ft diameter turntable; I. Jackson and Sons, Ltd., Lancaster, for repairs to slipway and traverser carriages, Fleetwood harbour; Dowsett Engineering Construction, Ltd., Tallington, Lincs, for provision of venturi meter and gauging station on the Shropshire Union Canal at Llantisilio, North Wales.

A Seven-Day Journal

Atomic Energy Information Freed

THE Order, S.R. & O., No. 100, 1947, now on sale at the Stationery Office, puts into effect the Minister of Supply's expressed intention of freeing the ordinary tools of the nuclear physicist which have no defence significance from the restrictions on the publication of information regarding atomic energy plant. The Order states that "there is hereby exempted from the provisions of Sub-section (1) of Section II of the Atomic Energy Act, 1946, the communication of any document, drawing, photograph, plan, model, or other information which describes, represents or illustrates any existing or proposed plant set out in Paragraph I of the Schedule of the Order, the purpose or method of operation of any such existing or proposed plant or any process operated or proposed to be operated in any such existing or proposed plant." The Schedule setting out the classes of freed plant gives the purposes as follows :—"Determining the existence or nature of any nuclear reaction not being a reaction involving the fission of atoms of atomic number greater than 89, and resulting in a total energy output from the plant in which the reaction takes place in excess of the total energy output ; detecting or measuring the properties of charged or uncharged particles ; producing or accelerating charged particles by electrostatic or electromagnetic fields, whether by means of cyclotrons, betatrons, synchrotons, electrostatic generators or other ion accelerators ; and generating charged or uncharged particles by the action on matter of accelerated charged particles or of uncharged particles, but not including the generating of neutrons by a reaction involving the fission of atoms of atomic number greater than 89, and resulting in a total energy output from the plant in which the reaction takes place in excess of the total energy output."

The Electricity Commissioners' War Report

THE twentieth report of the Electricity Commissioners has just been issued, covering the six-year period from April 1, 1939, to March 31, 1945. It therefore contains a review of the wartime operations of the electricity supply industry, as naturally it became necessary during the war years to withhold from publication any new information concerning developments within that industry and measures undertaken for its civil defence. So far as appears necessary, chronological treatment has been adopted in the present report in recording the formal applications and other matters dealt with during the period covered, whether under the statutory powers, including wartime powers, or under powers exerciseable by the Commissioners on behalf of the Minister to whom they are responsible. It may be recalled that when the Electricity Commissioners were first established in 1920 they were responsible to the Minister of Transport, but during the war period ministerial functions in relation to electricity supply, including functions relating to the Electricity Commissioners were transferred to the Board of Trade, and subsequently, in 1942, to the Minister of Fuel and Power. The subject-matter of the report has been grouped as far as possible under the following main headings :—Position prior to the war ; matters of general policy ; wartime demands for electricity ; constructional work and materials and wartime controls ; generating plant programmes and grid reinforcements ; capital expenditure ; electrical development during wartime ; electricity charges ; manpower problems of the supply industry ; air raid precautions ; fire prevention in electricity undertakings ; war damage and restoration of supplies ; fuel rationing and economy ; and the control of certain electricity undertakings. Amongst other matters included in the report are some observations on post-war electricity works and schemes. At the end of the period covered information on these matters furnished by the undertakers was being collated by the Commissioners and classified in accordance with the relative degrees of priority attributed by the undertakers to the various kinds of works. The estimates of capital expenditure for the whole of the works contemplated during the first five years of the post-war period amount to approximately £155,000,000 in respect of generation and about £227,000,000 in respect of other kinds of works.

Reconversion of Large Liners

THE announcement is made that during the next few months four of Britain's large passenger liners will be reconverted for normal passenger service. Quite recently the Furness Withy 22,424 gross ton turbo-electric liner "Monarch of Bermuda" left for the Tyne, where she will be overhauled and refitted at the Walker Naval Yard of Vickers-Armstrongs, Ltd. This work will provide the Tyne with one of its largest refitting jobs. It will be recalled that the ship was built at the Walker yard in 1931. A further ship which is now on her last trooping voyage is the Royal Mail Line 25,688 gross ton liner "Andes," which was completed by Harland and Wolff, Ltd., at Belfast just at the outbreak of the war. During the war she has travelled over 500,000 miles and has carried half a million troops. She will be refitted at Harland and Wolff's Belfast yard, and is expected to take up the Buenos Aires service from Southampton towards the end of the year. The Cunard White Star, 26,943 gross ton motor liner "Britannic" is expected at Liverpool next month, having completed her war service. She will be accommodated in the Gladstone Dock, and the work of reconversion will be undertaken by Harland and Wolff, Ltd. Next month the second unit of the Canadian Pacific Steamships' North Atlantic Fleet, the 20,123 gross ton "Duchess of Bedford," is expected on the Clyde for refitting, and she will be renamed the "Empress of India." A sister ship, the "Empress of Canada," formerly known as the "Duchess of Richmond," is now being reconditioned at the Govan yard of the Fairfield Shipbuilding and Engineering Company, Ltd., and the "Empress of Scotland" is expected to be released from war service in June.

Air Accidents

DURING last week-end two "Dakota" aircraft crashed while taking off from their respective airports. The first of these regrettable accidents took place on Saturday, January 25th, at Croydon, the machine involved being a "Dakota" operated by Spencer Airways and bound for South Africa. The aircraft is reported to have reached a height of about 15ft and then faltered and landed again, afterwards heeling over and skidding into a Czechoslovak "Dakota" which was parked on the left of the runway. Both aircraft were destroyed by fire ; twelve people unfortunately lost their lives as a result of the accident and seven of eleven survivors suffered some injury. The second accident occurred in Denmark on Sunday, January 26th, when a Dutch Air Lines "Dakota" engaged on the Amsterdam and Stockholm service crashed on taking off from Kastrup airport, near Copenhagen. In this case the sixteen passengers and the crew of six were killed, the passengers including Prince Gustaf Adolf of Sweden and Miss Grace Moore, the singer and film actress. The aircraft, it is stated, went through the usual inspection after arriving at Kastrup from Amsterdam, and on becoming airborne again appeared to rise at an abnormally sharp angle. The pilot appeared to be succeeding in getting it level, but then there was another sharp ascent to a height of over 300ft and the aircraft went into a spin and crashed. In the House of Commons on Monday last the Parliamentary Secretary to the Ministry of Civil Aviation was asked if he had any statement to make regarding the Croydon crash. He gave an assurance that so far as accidents in this country were concerned, thorough investigation would be made and the causes determined, so far as humanly possible, with a view to preventing any recurrence. At the same time he emphasised that it was essential to avoid misconception as to possible causes. There had been, he said, so far as the United Kingdom was concerned, no accident with "Dakota" aircraft which could be attributed to the total weight at which the aircraft was being operated.

Sheffield University Extensions

AT a meeting held in Sheffield on Thursday, January 23rd, a campaign was begun to put into action a plan for extending, over a period of ten years, Sheffield University. It is aimed to provide for four times as many students as in pre-war years, to provide a new foundry and greatly to extend the departments of metallurgy and engineering. The scheme was announced by Sir Henry Stephenson, Pro-Chancellor, who read a message from the Chancellor, the Earl of Harewood, who was unable to be present. Dr. Bramley appealed for local support, and the Vice-Chancellor, Dr. J. I. O. Masson, gave some facts with regard to the University, which he considered a well balanced one. Its ratio of men to women was, he said, four to one. Of its 1280 undergraduates, nearly 30 per cent were studying arts or law, while of the remainder branches of science, medicine, dentistry and engineering each claimed one-fifth. The total expenditure for the extensions was estimated at £6,000,000, of which £4,000,000 would be required for buildings and about £1,500,000 for new halls of residence. At a luncheon before the meeting the Lord Mayor, Councillor Ernest S. Graham, announced that a proposal had been made to give £50,000 towards the building fund. By the end of the meeting close upon £104,000 had already been subscribed.

The Future of the Welded Ship

OWING to increasing interest in the subject of welded ships, the Institute of Welding has formed a panel of experts to answer questions relating to the subject of future ships and whether they should be all-welded. The members of this panel of experts are :—Mr. W. G. John, of the Director of Naval Construction Department, the Admiralty ; Mr. J. L. Adam, chief surveyor, British Corporation Register of Shipping and Aircraft ; Mr. H. H. Hagan, of Lobnitz and Co., Ltd., Renfrew ; Mr. C. Stephenson, of R. and W. Hawthorn Leslie and Co., Ltd., of Newcastle-on-Tyne ; and Dr. J. H. Paterson, of the Arc Manufacturing Company, Ltd. At a meeting of the Institute held on Wednesday evening, January 29th, at the Institution of Civil Engineers questions were put on such subjects as the use of heat-treatable alloys of the duralumin type and high-tensile steels for light scantlings on fast naval vessels ; the education of inspecting personnel ; the relative cost and weight of all-riveted and all-welded hulls ; the desirability of some riveting ; the possibility of building flexibility into an all-welded hull ; the possible uses of thin cellular plate construction for diagonal stiffening in order to lighten and cheapen ship design ; and the possibility of employing flange plates, as in the automobile industry ; the buckling of plates between frames in welded construction ; the suitability of ship steels for welding ; the possible utilisation of the Isherwood system of framing in an all-welded ship ; and methods of protecting weld metal on galvanised plates in order that the weld may have the same resistant properties as the plate material.

Water Treatment and Filtration Plant at Chicago

By E. E. R. TRATMAN

No. II—(*Continued from page 89, January 24th*)

FILTRATION as the only sure means of both cleaning and purifying the city's contaminated water supply, under the conditions already explained, had been advocated for years by engineering and medical authorities. But such projects met, invariably, with strong opposition, largely on the basis of the cost involved. Another disturbing factor in the filtration problem was its relation to metering of the water consumption. The Chicago people had a general objection to the meter system, as applied to the domestic supply, on the ground that with such an enormous source of supply at hand there should be no charge for the use of water. They ignored the points that the water had to be pumped to the consumer and that tunnels, pipes, pumps and pumping involved heavy expense. As a result of this attitude, the use and waste of water has been excessive. With only a partly metered system in 1940, the average daily consumption was 264 gallons per capita. A study of the situation indicated that with uncontrolled use of water that had been treated as well as pumped, the filtration project was economically impracticable. Under war conditions, however, the disposal of the meter system question had to be deferred, but several thousand meters are to be installed when the filtration system is in full operation.

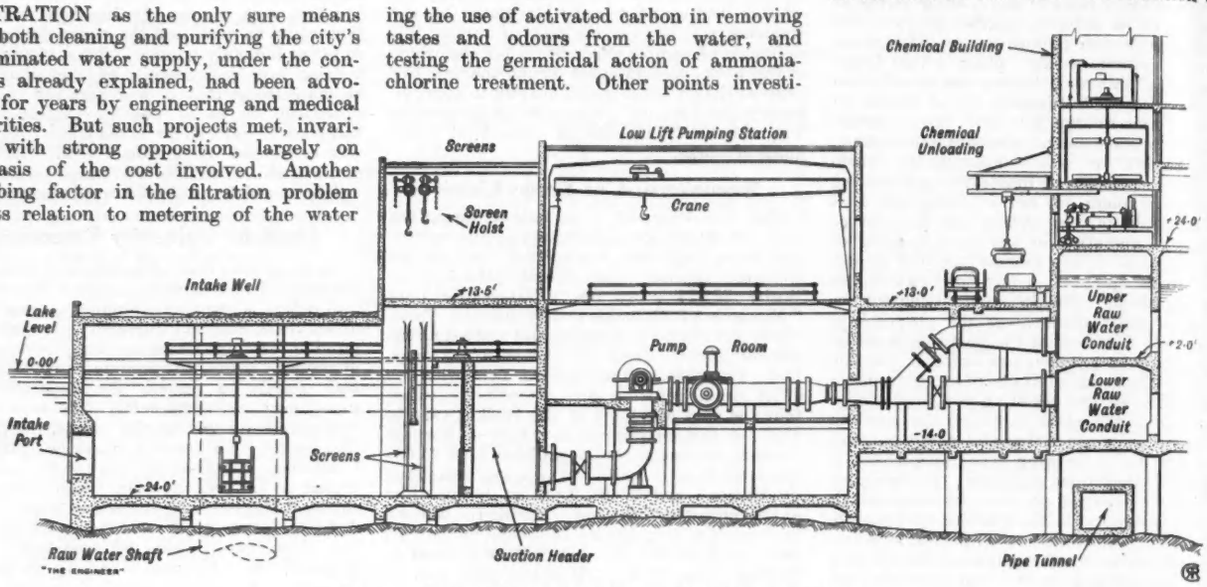


FIG. 6—SECTION THROUGH INTAKE, PUMPS AND CONDUITS

DEVELOPMENT OF FILTRATION

In May, 1925, Mr. John Ericson, then city engineer of Chicago, recommended the construction of an experimental filtration plant, largely on account of two factors, namely, the increasing pollution of water taken in to supply the southern section of the city and the increasing complaints as to objectionable tastes and odours in the water, caused mainly by the heavy chlorination treatment necessitated by sanitary requirements. In July, 1926, the City Council appropriated the sum of £12,500 for such a plant, for the purpose of determining the most effective and economical method of treating lake water under the local conditions and the character of the pollution.

This experimental filter plant was put into operation in 1928, and served for research along various lines, including testing the use of activated carbon in removing tastes and odours from the water, and testing the germicidal action of ammonia-chlorine treatment. Other points investigated were surface washing of filters to prevent the formation of mud balls; testing the effectiveness of various filter media, and testing the use of silica compounds to facilitate coagulation.

A definite project for water treatment, as then planned, on the basis of this experimental work, provided for four plants along the 24-mile water front of the city. This was changed later to provide three such plants, serving the southern, central and northern sections of the city. It is the first of them, for the southern section, which is now approaching completion and is already in partial operation.

In 1930, filtration of the city's water supply was approved by public vote. After a protracted period of planning and legal proceedings, combined with procedures necessary to obtain financial assistance from the Federal Government, contracts were let and construction was commenced in 1938. This work was curtailed greatly during the war period of 1941–1945, with its withdrawal of critical materials and men, and its prohibition of works not connected directly with war service. Work was resumed on a larger scale in 1945, and was so far completed in that year as to permit chlorination, coagulation and sedimentation of water drawn from the lake, although the filters were not then ready for service.

THE NEW WATER TREATMENT PLANT

This new plant for water purification, situated on the Lake Michigan shore at 79th Street, is built on a 40-acre site, formed by filling of reclaimed land in the lake, so that no purchase of property was involved as an item in the cost. Its situation and general arrangement have been described in the preceding part of this article.

For its construction, an area of submerged land, 1600ft by 1000ft, was enclosed by a clay dyke or cofferdam, having a central core of steel sheet piling, with steel wales. Its slopes were protected by rock filling or revetment, and heavy blocks of stone formed a cap or crest 6ft above water level. The maximum depth of water on the site was 20ft. The head of this enclosure is protected from storm waves by a rock breakwater, 2700ft long placed about 970ft in advance. After the enclosed area had been de-watered, all soft material was excavated down to the solid rock, the substructures of the buildings being then built

FIG. 7—LOW-LIFT PUMP ROOM

in the dry. Walls are supported on rows of short concrete columns seated on the rock. Space not occupied by the buildings was filled and landscaped. At the west or land end, the filling was extended to meet the normal level of the adjacent ground. On the north side a city park and a bathing beach, 3300ft long, were formed by depositing sand and granulated slag outside of the cofferdam. Sand for the beach was pumped in from hydraulic hopper dredges, being retained in position by a submerged weir of loose rock.

On this prepared site are two main buildings of reinforced concrete. The one at the east or lake end, 850ft by 480ft, contains the following facilities, in the order named: Intake of raw-water basin, screen chamber, low-lift pump room, raw-water header basin, chemical mixing basin, coagulating or flocculating basin, and settling or sedimentation basins. The building at the west or shore end, 700ft by 900ft, contains eighty filter beds, arranged in four groups of twenty each. From the sub-drains of the filter beds the water is delivered to a battery of eight collecting basins, from which, in turn, it flows to the main filtered-water or clear-water reservoir, 260ft by 900ft, having a capacity of 32 million gallons. The dimensions of the several basins are listed in the table overleaf.

Four steel-frame buildings are auxiliary to the concrete structures. At the west end, fronting on the main approach, is the administration building, which, with its wings, contains the general offices and main chemical laboratories. In its rear is the filter building, 400ft by 600ft, containing the filter beds and their operating galleries, wash-water pump room and tank. Over the chemical mixing basins is the chemical building, 480ft by 60ft, with the feeding apparatus for chemical solutions and storage for capacity for thirty days' supply of the various chemicals. For delivery of these supplies, the building is served by a rail siding and a 40ft roadway for motor trucks or lorries. Further east is the low-lift pumping station, 500ft by 90ft, with pump room, boiler room for heating the plant, electric equipment, machine shop, and a room for handling and cleaning the screens in the intake basins.

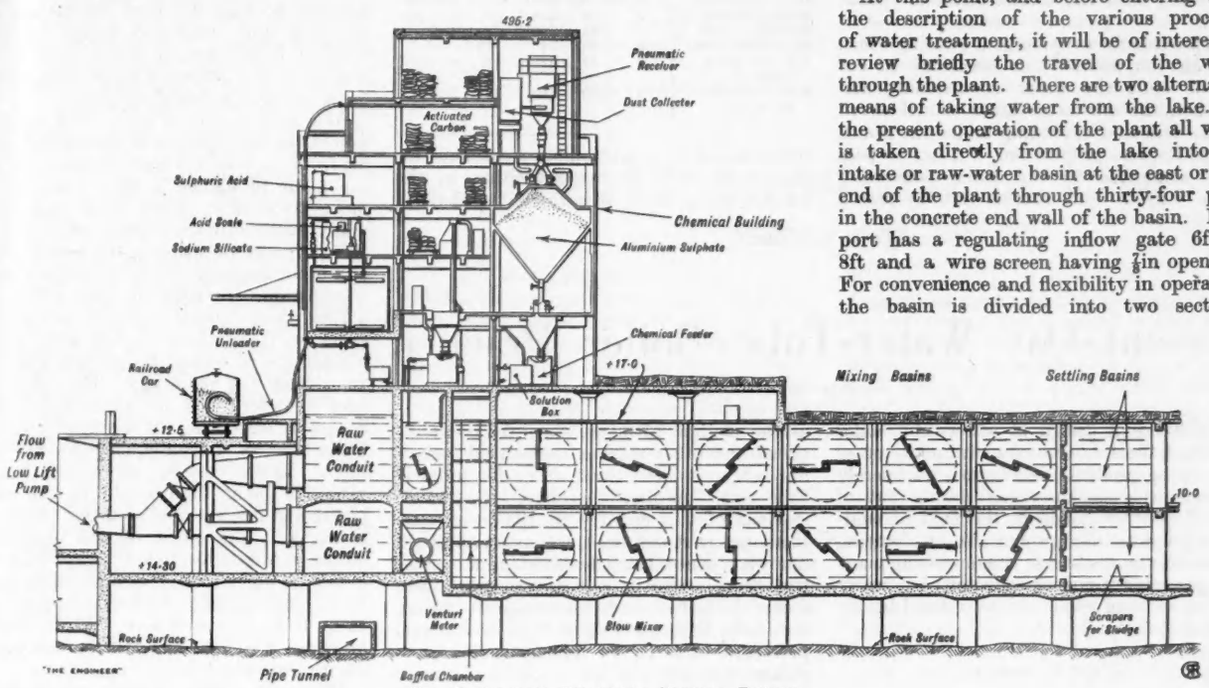


FIG. 8—SECTION THROUGH MIXING BASINS

Arrangement and Equipment

The arrangement of the plant and its equipment was shown in the general plan and section, Figs. 2 and 3, *ante*. Further details are given in the accompanying drawings and photographs, Figs. 6 to 9. Thus, in Fig. 6, looking south, the intake basin, with its ports for direct inflow and the head of the raw-water intake shaft from the 16ft tunnel are shown at the left. Then come the suction header, the pump room and the double discharge to the double-deck raw-water conduit or header. A view of the pump room is shown in Fig. 7. The longitudinal section is continued in Fig. 8, showing the pump discharge and conduits at the left, followed in succession by the venturi meters, the baffled chamber for mixing the chemicals, and then the mixing and settling basins, with their appurtenances. A typical cross-section through the triple unit double-deck settling basins, in Fig. 9, shows also how the structure is supported on the foundation rock by rows of short columns, as noted previously.

Inflow and Outflow

At this point, and before entering upon the description of the various processes of water treatment, it will be of interest to review briefly the travel of the water through the plant. There are two alternative means of taking water from the lake. In the present operation of the plant all water is taken directly from the lake into the intake or raw-water basin at the east or lake end of the plant through thirty-four ports in the concrete end wall of the basin. Each port has a regulating inflow gate 6ft by 8ft and a wire screen having $\frac{3}{4}$in openings. For convenience and flexibility in operation, the basin is divided into two sections, so that one can be shut off for cleaning or repairs, while the other continues in service.

Water from the intake basin passes through screens to a suction well serving a battery of eight low-lift centrifugal pumps of the horizontal, single-stage, double suction type directly connected to synchronous motors. Four of the pumps have a capacity of 100 million gallons daily, and the others 50 million gallons. In various combinations, they provide for a widely fluctuating hourly flow, and the flow from each pump is recorded by a venturi meter. These pumps have double discharge outlets, delivering the water into the upper or lower sections of a double-deck conduit or chamber. The lift averages 20ft above lake level. Beyond this stage the treatment of the raw water begins.

After passing through such treatment processes as may be required by the degree of pollution and general characteristics of the water, the treated water finally enters the clear-water basin, at the west end of the plant. Thence it flows through regulating gates into the outlet shaft, descending to a 16ft tunnel, which connects with other land tunnels extending to the three pumping stations which serve the

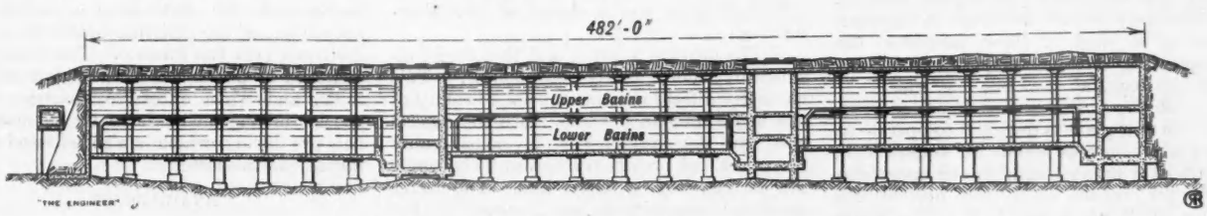


FIG. 9—LONGITUDINAL SECTION THROUGH SETTLING BASINS

distribution system of the southern section of the city.

The alternative supply, mentioned above, is from the Dunne crib and its 14ft intake tunnel through a connecting 16ft tunnel, a mile in length, which parallels the outlet tunnel. This 16ft tunnel extends under the plant to the east end, where it serves two rising shafts which discharge the water into the double-chamber intake basin.

To provide for any emergency during which it might be desirable or necessary to cut out or omit the water conditioning and filtration, the raw-water intake tunnel served by the crib and extending under the plant, has, at its west or land end, a rising by-pass shaft connected to the main clear-water basin. From this basin the by-passed raw-water may be discharged into the 16ft outlet shaft and delivered to the pumping stations. Any conditioning treatment for this water may be applied either in the by-pass rising shaft, or in the outlet shaft.

Basins in Water Treatment Plant at Chicago, U.S.A.

Basins	No.	Dimensions (feet)	Depth (feet)	Time
Raw water intake basin	1	18 × 400	33	—
Chemical application chamber	3	9½ × 120	14	1·6 min
Baffle chamber	3	8½ × 120	34	3·5 min
Mixing basins ...	3	138 × 118	32	50·0 min
Settling basins ...	3	138 × 500	32	3·7 h
Sand filter beds	80	26 × 54	11½	—
Filtered water basins	8	53 × 320	16	1·1 h
Filtered water reservoir	2	280 × 450	19	2·7 h

(To be continued)

Present-Day Water-Tube Boiler Practice

THE trend of design of water-tube boiler installations, in common with many other engineering products, is affected, not merely by technical considerations arising out of general progress made in the field of engineering and metallurgy, but also by changing economic circumstances. Steam-raising plant for power stations is affected by many factors, some of which are considered briefly in what follows :—

Unit Capacity

It is interesting to note that about 1936 the average evaporative capacity at maximum continuous rating of a single unit installed in a power station in this country was of the order of 150,000 lb to 180,000 lb of water per hour, although there were a certain number of units of considerably larger capacity. To-day the corresponding average figure for evaporation would be between 300,000 lb and 350,000 lb of water per hour.

Pressures and Temperatures

Coincident with this increase in the average size of unit there has also been an increase in pressures and temperatures. In 1936 the normal pressures were 400 lb per square inch and 650 lb per square inch, an approximately equal number of stations operating at each of these pressures, the corresponding steam temperatures being about 750 deg. Fah. and 825 deg. Fah.

In 1946 the position is changed, as practically no new plant is designed to operate at so low a pressure as 400 lb per square inch, and whilst a number continue to operate at 650 lb per square inch, the normal has become 900 lb per square inch with a steam temperature of 900 deg. Fah. In a few cases pressures of 1200 lb to 1500 lb per square inch with temperatures of 925 deg. Fah. or even higher are now being adopted. It is interesting to note that in 1926 the average steam pressure was as low as 200 lb to 300 lb per square inch at a temperature of 600 deg. to 700 deg. Fah.

Firing Equipment

The practice of installing units of 300,000 lb to 350,000 lb per hour evaporative capacity at the present time means that a very much greater proportion of the power stations in this country are adopting pulverised coal as the method of firing, since for constructional and other reasons mechanical stokers are not considered satisfactory for units of this size. While, therefore, the power stations of this country in 1936 were preponderantly stoker fired, the majority of the new plant is now being designed for pulverised fuel firing. The movement towards higher steam pressures and temperatures means, naturally, that parts subject to these higher pressures have to be heavier and with a steam temperature in excess of about 875 deg. Fah. alloy steel is necessary for the construction of the parts affected.

Feed Water Temperatures

With higher steam pressures and temperatures available at the turbine stop valve, the turbine designer seeking increased efficiency adopts interstage feed heating to an ever-greater extent. As a result the feed water returned to the boiler unit is frequently raised to a temperature beyond the optimum desirable for the most economical boiler design. The increased temperature of the feed water creates difficulties in the design of the economiser, since there is a reduced temperature difference between the water on the one side and the gases leaving the boiler on the other.

The designer has a choice of two alternatives :—

(1) To provide a larger and therefore considerably more costly economiser. This naturally affects the commercial economy of the boiler unit as a whole, since the capital cost of the economiser is considerably increased and provision has also to be made for an increased draught loss. The latter provision necessitates an increase in the running cost throughout the life of the boiler unit.

(2) To increase the size of the air heater, which, not being subject to pressure, is less costly than increasing the size of the economiser. However, the resulting higher air temperatures are frequently in excess of those suitable for mechanical stokers. This is one of the causes of the increasing adoption of pulverised fuel as a method of firing.

It will be clear that these changes in design must increase the capital cost per unit weight of steam produced. Normally, increase in unit size implies a slight reduction in capital cost per unit of output, but this saving in the case of boiler plant is generally offset by the increased cost of accessory equipment necessary to the successful operation of the larger units.

Fuel

The factor which has had perhaps the greatest single effect on the design of present-day boiler units is that of the fuel available. In 1936 power station authorities were generally in a position to allow the boiler designer to base his work on the use of a specified and restricted range of coals, detailed particulars of which were usually available, the characteristics of such fuels being not very widely divergent.

As a consequence of the general deterioration in the coal position of the country resulting from the war, it is now necessary to design the plant to handle a very wide range of fuels, frequently drawn from any of the many coalfields in the country. Consequently there is great variation in the heating values and other important characteristics affecting combustion. In spite of these added difficulties the designer is expected to accept the same or, if anything, rather more onerous obligations in regard to performance than were usual ten years ago. The boiler engineer therefore has no alternative but to design by legislating for the worst conditions likely to arise. In consequence a much higher initial capital cost is incurred in the provision of plant than would be the case if better and less variable qualities of coal were available. The effect of the present fuel situation is reflected in very many ways when details of boiler and firing equipment have to be considered, but space does not permit them to be fully discussed here. As an example, however, the following two factors may be mentioned :—

Where the coal available varies, as is so frequently the case, in heating value from between 8000 and 9000 B.Th.U. per pound up to 13,000 B.Th.U. per pound, with an ash content varying from some 7 per cent up to 30 per cent, the designer has no alternative but to base on the worst condition, and must provide firing equipment some 30 per cent larger than if high and unvarying quality coal was available. This has the twofold effect of increasing the cost both of the firing equipment and of the boiler itself. The quantity of ash to be handled being three times as great, the ash plant must of necessity be considerably more costly.

A second factor is the wide range of moisture content in the coals. Where it occurs associated with units arranged for pulverised fuel firing, special provision has to be made for abstracting a considerable proportion of the moisture before the coal is delivered into the furnace. This removal is achieved by pre-drying in the pulverised coal mills, and when excessive moisture exists special arrangements have to be made for this pre-drying, which is also reflected in the initial capital cost.

Availability

High boiler availability, which is a measure of the ability of a boiler unit to steam continuously at full output over extended periods of at least six months, has during the last few years been exercising the close attention both of boiler users and designers. Two considerations render this an important feature in the performance of a boiler plant :—

(1) The fact that it is uneconomic for plant involving considerable capital outlay to be out of service for more than the absolute minimum period, since to the extent which such plant is out of service additional stand-by plant has to be installed in order that the load demand may be met.

(2) Under present-day conditions where

electricity demands are so frequently in excess of the capacity of existing plant, it will be evident that the less the availability of boiler plant the greater will be both the amount and frequency with which it will be necessary for the authorities to shed load. Conversely, the greater the availability the less frequently will load need to be shed and the shedding will be smaller in degree.

How do these requirements affect the boiler designer? In the first place, it is necessary for him to be more liberal in selecting the ratings upon which he bases his calculations in designing all those sections of the plant which are affected by the fuel that is available. This consideration is not restricted to the combustion equipment proper, but also applies to the disposition and extent of the various heat recovery sections of the plant. This problem in its very nature is one of no mean proportion. When, however, there is added to it the fact that the fuels which are available to-day are frequently very low in quality and vary widely in characteristics and perhaps—and most important of all—the supply to an individual boiler unit is likely to change frequently and possibly without notice, the magnitude of the problem facing both designers and users will be better appreciated.

It is common knowledge that plant designed before the war has in a number of cases given unsatisfactory availability under wartime conditions and fuel supply. To mitigate these difficulties with the new plants now going into service or under construction a considerably more liberal design has been found necessary.

Efficiency

In spite of the deterioration in coal supplies there has been no falling-off in the demand for highly efficient plant. When comparison is made with the practice, either on the Continent of Europe or in the U.S.A., British power stations have always been noteworthy for the high overall thermal efficiency of their steam generating units.

At the present time the highest possible efficiencies are more than ever necessary, whether considered either from an economic or a national point of view. In the first case the greatly increased cost of coal causes the user to demand the utmost from the fuel, and in the second case the national necessity of burning the minimum quantity of coal for a given output is apparent. Yet the designer is expected to meet these requirements with the lower quality of coals now available.

All these additional demands on the boiler designer must involve the user in increased initial expenditure. These requirements, moreover, make necessary the general employment of various kinds of auxiliary equipment which ten years ago were installed in exceptional circumstances only. Among such equipment may be mentioned:—

(*a*) Equipment for automatic steam temperature control over a considerable range of load.

(*b*) Electrical or hydraulic systems for the automatic operation of soot blowers.

(*c*) Equipment for the complete automatic control of the whole of the steam generating unit.

Conclusion

In the foregoing some attempt has been made to describe the general trend of design and in particular the difficulties which have to be surmounted in meeting requirements under existing conditions of fuel supply. The following approximate figures indicate that a considerable measure of success has been achieved:—

It can be said that with a plant of the highest efficiency now under construction some 10 per cent less heat units will be required to generate one unit of electricity as compared with the number of heat units necessary for a plant representative of good practice ten years ago. Expressed in another form, this reduction of 10 per cent would represent a saving of about 2 million tons of fuel per annum consumed in the generating stations of this country if all plant had been designed and was operating in accordance with present-day practice. For an equivalent output the saving in running costs would be between 4 and 5 million pounds sterling per annum.

Fuel costs to-day are about three times greater than they were in 1936, and if allowance is made for the inferior qualities now available this increase would be even greater. Capital expenditure on power station plant has also increased, not only as the result of rise in the cost of labour and material, but also to the factors referred to earlier. Yet over the same period the average increase in charges for electricity supplied to consumers has only been some 10 to 15 per cent. That this result can have been achieved is no small tribute to the electricity generating industry, on the one hand, and the designers of power station equipment, on the other.

Electrical Engineering in 1946

No. IV—(*Continued from page 94, January 24th*)

Gas Discharge Lamps

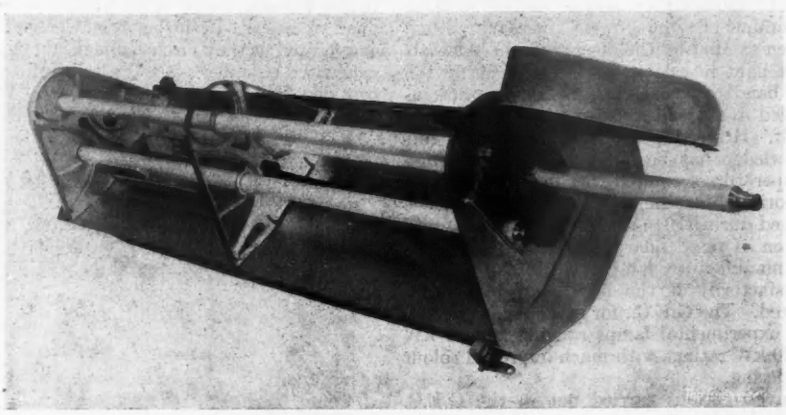
THE youngest member of a growing family of light sources—the fluorescent lamp—was the subject, during 1946, of intensive work, aimed at attaining higher luminous efficiency and adapting the lamp to new uses.

An interesting development is the application of fluorescent lamps to illuminating hospital operating theatres, where a high intensity must be provided with the light falling on the patient over a wide range of angles giving the so-called "shadowless" lighting. At the same time the radiant heating must be kept to a low value. In a recent installation at the Westminster Hospital, the G.E.C. used five 80-watt daylight lamps in concentrating reflectors arranged in an arc, so that the effective light source was in the form of a 5ft by 4ft rectangle, giving shadowless illumination of about 400 lumens per square foot with the fitting mounted at a height of 3ft above the operating table. To provide this installation with emergency lighting of about 150 lumens per square foot, four 100-watt tungsten filament lamps were mounted in separate parabolic reflectors housed in the ends of the main fitting and wired to an alternative source of supply.

The possibility of using tubular fluorescent lamps for street lighting were thoroughly examined and discussed in a most informative paper* which was presented at the Annual Conference of the Association of Public Lighting Engineers in London on September 12, 1946. Commencing with a study of the new light source in relation to other factors affecting street lighting, the authors of the paper proceeded to describe the evolution of a new form of lantern designed to accommodate a number of 80-watt tubular lamps, disposed in such a way as to satisfy the special requirements of street lighting as applied to arterial roads, civic centres and shopping areas and side streets. The work described in the paper was carried out in the B.T.H. Company's research laboratories, and culminated in two interesting experimental installations, which indicate that fluorescent lamps, with their excellent colour rendering, should fill an important *rôle* in street lighting for town centres, although the cost of alternative lighting systems may prove to be lower.

The first experimental installation mentioned above was switched on in High Street, Rugby, on August 1st. A few weeks later the second installation was put into operation in Bond Street, London, and an impression of the new lighting in this important thoroughfare is given in an engraving overleaf. The lantern used for both of these installations houses three 80-watt tubular lamps, each with its own reflector. A view of the partly assembled lantern, showing the method of lamp replacement and the accessible position of the starters, is reproduced above. Supporting poles were dispensed with in the Rugby and Bond Street installations, the lanterns being carried on a double-wire span system, with a simple tractive wire device to enable the lantern fitting to be pulled to the kerbside for servicing.

Similar development work on fluorescent lighting for streets has been carried out by the G.E.C., Ltd. This company was responsible for the experimental installation in the Brompton Road, Kensington, illustrated overleaf. Our engraving gives some idea of



PARTLY ASSEMBLED LANTERN

* "Experimental Application of Tubular Fluorescent Lamps to Street Lighting," by L. J. Davies and W. D. Sinclair.

the uniform high intensity of illumination achieved by a combination of central and kerbside lighting. Seven 80-watt 5ft tubular lamps, with suitable parabolic reflectors, are housed in each lantern fitting. The G.E.C. is also studying the problems involved in the lighting of secondary and residential roads by fluorescent lamps.

STREET LIGHTING BY FLUORESCENT LAMPS IN OLD BOND STREET AND IN BROMPTON ROAD, KENSINGTON

Good progress has been made in the design of the high-pressure mercury vapour lamp; in particular, its colour rendering properties have been improved. For a number of years it has been known in principle that the colour of light emitted by a mercury vapour lamp can be modified by adding metals such as cadmium or zinc to the mercury filling. When excited by the discharge, these metals emit light in certain parts (particularly the red band) of the spectrum that are not included in the emission from mercury vapour itself. Hitherto practical application of this knowledge has been hindered by the high temperature required inside the lamp to vaporise the cadmium or zinc. Experience gained during 1946 in the working and application of fused quartz has made it possible to manufacture lamps which can be run satisfactorily at the high temperatures required. The G.E.C., for example, is producing experimental lamps ranging from 1 kW to 20 kW ratings with much improved colour rendering.

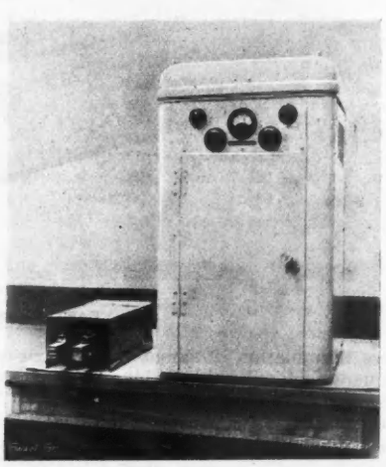
Investigations carried out in the G.E.C. research laboratories indicate the possibility of substantially improving the efficiency of high-pressure mercury vapour lamps. A luminous efficiency of about 70 lumens per watt is envisaged, and any such improvement will have far-reaching results. Another interesting advance is the design of larger lamps which are being made experimentally with ratings as high as 25 kW.

Engineering Tools in Nuclear Research

The field of nuclear physics, with its fascinating potentialities for good and for ill, provides the electrical engineer with great scope for new and widening activities. In another article we have discussed the wider implications of atomic energy in the light of present-day knowledge. Our immediate purpose will therefore be to indicate very briefly the part that can be and is being played by British electrical manufacturers in facilitating the study of nuclear physics.

An outstanding example of the special apparatus designed to aid research is the synchrotron—an electron accelerating device working on generally similar principles to the betatron—which is being built by Metropolitan-Vickers Electrical Company, Ltd., on behalf of the Ministry of Supply for use in atomic and nuclear research. This apparatus will be installed in the University of Glasgow and will enable electrons with an energy of 300 MV to be produced. The synchrotron will be comparable in size and performance with similar equipments now under construction in the U.S.A.

Another important Metrovick equipment is the 20 MV betatron which will be supplied to the Christie Hospital for the X-ray treatment of cancer. In the betatron electrons are accelerated as they circle a dough-nut shaped evacuated chamber placed between the poles of a powerful 3·5-ton electromagnet. When the electrons finally strike the "target" they produce X-rays of great penetrative power. It is well known that the curative dosage given by conventional X-ray tubes is limited by the accompanying burning of the patient's skin. The penetrating power of X-rays produced by the betatron, however, allow relatively greater curative doses to be administered for the same degree of skin-burn.



ELECTRONIC MAGNETISING EQUIPMENT

The manufacture of this kind of equipment has given rise to rapid developments in magnet construction, with an increased demand for powerful magnetising apparatus. Very heavy unidirectional impulse currents provide an effective and efficient means of magnetising large permanent magnets. For this purpose Ferranti, Ltd., has developed a self-contained equipment using an ignitron with its ignition controlled by a gas-filled strobotron, the control grid being connected to a peak wave transformer of adjustable phase. An engraving on this page shows the magnetising equipment in its latest form, with a heavy current transformer for use where single-turn magnetising coils are required. Very heavy currents can be produced over any period not exceeding a half cycle. The equipment illustrated here is capable of producing 200,000 ampere turns of excitation. This figure is sufficient for existing demands, but it does not constitute a limit, and higher values of excitation are attainable.

Proposed North Devon Power Scheme

Discussions are proceeding for the erection of a new big power station in North Devon. The site at present favoured and which is being subjected to technical investigation is at the foot of Westleigh Hill, between Instow and Bideford, on the River Torridge. The plan is to provide electricity for the whole of North-West Devon and North Cornwall, and is an attempt to meet the demand which at present exists, and which continues to grow, for the supply of current for light, heat and power throughout the rural areas. A survey of the district has been completed and boring work is now in progress. Should, as is expected locally, successful reports be received and the scheme proceeded with, ancillary works will include an entirely new port in the neighbourhood of Bideford and a deep-water channel on the right bank of the river. Among the present generating stations which will be incorporated in the scheme is the one at Barnstaple, which will be retained as a transformer and distributing station. The Barnstaple station was for many years a matter of local contention, but, having been maintained to modern standards, its operation has in recent years provided satisfactory financial surpluses. It is expected that the new station, when in full operation, will require a staff of some 300 employees; its cost is at present conjectural. The possibility of the future development of a new industrial area or trading estate in the district must not be ruled out.

Recent Developments in Flying Boats*

By HENRY KNOWLER†

No. II—(*Continued from page 93, January 24th*)

Flying Boat Construction

Materials.—Before describing the construction of flying boats, it is best to deal first with the materials in general use. Aluminium alloys are practically universally used in the structure of hulls and wings,

FIG. 6—"2/33" FRAME

metal having displaced wooden construction some twenty years ago for aircraft use. Where weight is of such importance, the light alloys are greatly superior to the highest tensile steels. Magnesium alloys are attractive from many points of view, but unfor-

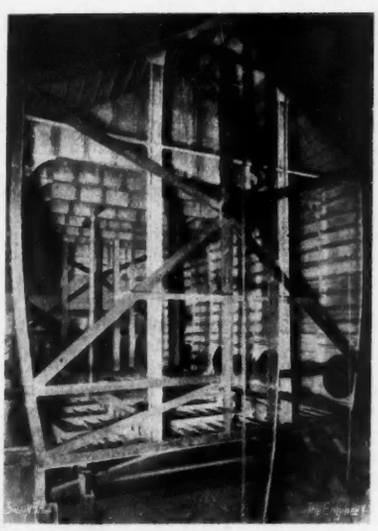


FIG. 7—LOWER FRAME OF "SHETLAND" FLYING BOAT

tunately are much inferior to the aluminium alloys in corrosion resistance. For landplanes there should be a great future for the new zirconium alloys, the high specific strength of which is very striking, but they are not yet available commercially.

Most of the aluminium alloys now in use are obtainable as extrusions in almost any shape and size. They are much favoured in flying boat construction, and in large boats have almost displaced sections rolled from sheet or strip. Sheeting material is usually specified with the pure aluminium coating, called "cladding" or "alclad." This, particularly when anodised, renders the material highly resistant to sea water corrosion. Although "alclad" sheet is sometimes used without further treatment other than painting, extrusions and other parts are always anodised and finally protected by cellulose paint or a thin coating of Lanoline; but the latter must be renewed fairly frequently, and is only used on civil boats in order to facilitate inspection.

Although aluminium alloys of high tensile properties are available, such as D.T.D. 363, it is necessary to use a considerable amount of steel in machine construction, particularly for highly stressed parts, such as joints between components, and also for moving parts.

Light alloy castings are used extensively in recent designs. Protection from corrosion, however, is not always satisfactory, and forgings are more suitable for external use.

Hull Construction.—Turning now to the methods of construction employed in the manufacture of present-day flying boats, most hulls are built on the transverse principle, where frames and bulkheads carry the loads to the shell of the hull, the latter providing the main longitudinal strength. Frames are spaced at pitches of from 12in to 30in. The boundary members are usually directly riveted to the shell covering and reinforce the latter against fore-and-aft bending.

Longitudinal stringers on sides and planing bottoms are supported by the frames and are, in conjunction with the frames, used to break up the shell into small panels. Stringers are either intercostal or continuous; in the latter case the frames are slotted where the stringers intersect. In both cases the two members are joined together with small brackets. The pitch of stringers is usually from 6in to 9in.

The bottom, particularly forward of the step, must be of robust construction, as water pressures locally may be of the order of 40 lb per square inch. In this region the plating thickness is from $^1/_{10}$in to $\frac{1}{8}$in, and the stringers are Z section or bulb angle extrusions. Sometimes intercostal stringers made from sheet are used.

The sides of the hull are dealt with in a similar manner to the bottom, but lighter scantlings are used, the skin being 18 or 20 and even 22 S.W.G. in thickness.

Two forms of keel are in general use, one an extruded member of shallow depth formed to I beam section, the other type being a fairly deep keelson built up with web and top and bottom flanges. The advantage of the latter type is the additional support given to individual frames against highly concentrated loads.

The wing structure is generally attached to two sturdy root frames which diffuse the wing loads into the hull structure. These frames are built up from extruded sections and are frequently of double-web construction.

All external surfaces are flush riveted, and lap joints are joggled. The joints are made with marine glue, and other preparations, such as chromate varnish or "bostik," and a watertight pitch of rivets is used. In spite of the thin plating, little trouble is found in making the joints watertight by these means.

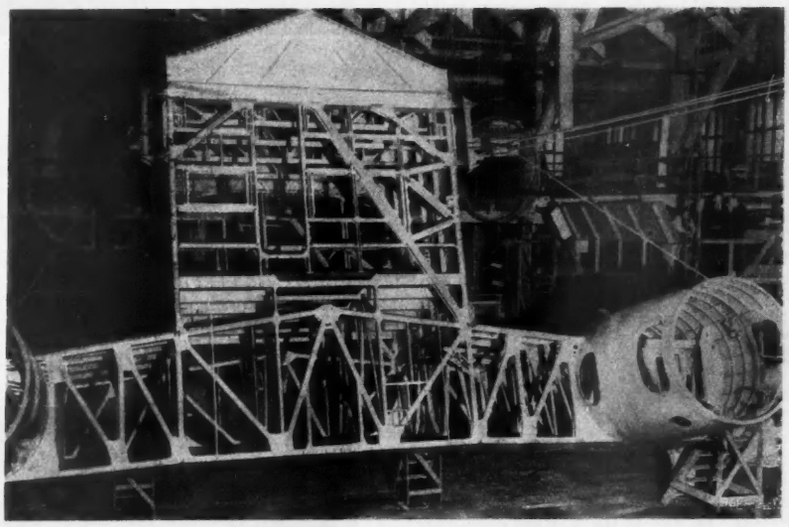


FIG. 8—"BOEING" "314" FRAME

The flush surface mentioned is necessary, not only for aerodynamic reasons, but also to reduce the planing frictional resistance of the bottom, which may reach 50 per cent of the total hull resistance towards the end of the take-off run.

Figs. 6 to 11 show typical examples of hull construction by various makers.

Pressurising. — Recent specifications for both landplanes and flying boats require flight at great altitude. This has introduced the problem of pressurising. Civil types usually operate with a minimum internal pressure equivalent to 8000ft altitude, but the machine may be required to fly at a height between 25,000ft and 40,000ft, or even higher. This requires internal pressures up to 8 lb per square inch.

Fig. 12 shows the cross sections of bodies designed to withstand pressure. The obvious

* Institution of Mechanical Engineers. January 17th, Thomas Lowe Gray Lecture. Abstract.

† Chief designer, Messrs. Saunders-Roe, Ltd., East Cowes, Isle of Wight.

and simplest form is a cylinder on which the planing bottom is built.

The two-deck arrangement is also possible if the upper deck is placed at the intersection of the two circles. This is known as the "double-bubble" form. A third method used in the Saunders-Roe civil boat is shown. The lower deck in this case is used to carry the internal pressure. At first sight this might be thought to be a heavy method, but it is found that by using the strong planing bottom structure to reinforce the deck, little additional weight is required to withstand the internal pressure.

Bulkheading.—It is usual to specify watertight bulkheading for flying boats, the requirements being that the machine must remain afloat with two compartments holed. In small boats, it is usually necessary to carry the top of the bulkhead above the floor level. The partitions in this case are closed either with watertight doors or by swash boards. In large flying boats watertight compartments can be below the floor line and the number to be provided is only restricted by weight considerations. With the pressurising method just mentioned, where the lower deck carries the pressure, a valuable horizontal bulkhead is available. In a recent design

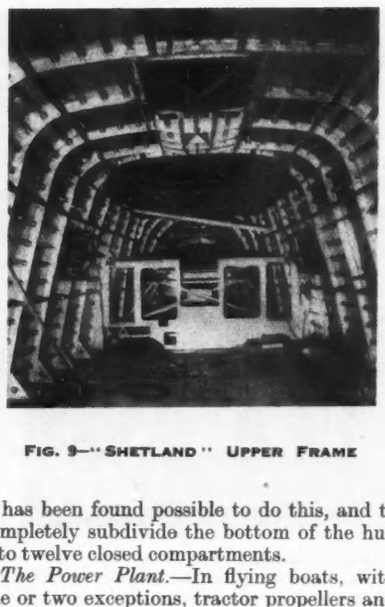


FIG. 9—"SHETLAND" UPPER FRAME

it has been found possible to do this, and to completely subdivide the bottom of the hull into twelve closed compartments.

The Power Plant.—In flying boats, with one or two exceptions, tractor propellers and forward-mounted engines have been used. Generally, a case can be made for the pusher propeller, since improvement can be claimed for :—

(*a*) Improved laminar flow over the wing, resulting in a lower drag.

(*b*) Lower engine drag due to their not being placed in the slipstream.

These advantages are, however, offset by a number of practical disadvantages. An aircraft with engines at the trailing edge is difficult to balance, and the centre of gravity may be too far aft ; therefore a shaft drive may be necessary so as to permit the engine to be mounted forward in the wing—an arrangement which, besides being heavy, introduces other engineering problems. Another disadvantage is that, although the engines may be made accessible for maintenance, they are more difficult to replace. The main reason, however, for this preference for tractor propellers is the greatly increased vulnerability to spray when propellers are mounted behind the wing.

With the advent of the jet turbine, attention has naturally been directed to the special advantage it can offer to the flying boat by the possibility of reducing the wing height and improving the aerodynamic efficiency by submerging the units in the wing section or body. These advantages have been appreciated, and, in fact, a small experimental flying boat has been built by my firm to test the possibilities of this form of propulsion.

The advantages to the civil transport machine, however, are not overwhelming,

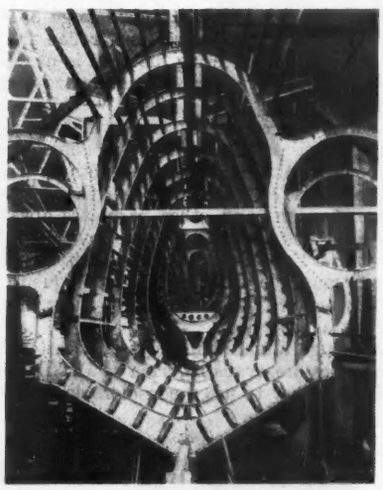


FIG. 10—"SR/A1" TAIL FRAME

and, although it is possible that jet propulsion will be used in a future generation of flying boats, there is still much to recommend other forms of power plant. The choice, in fact, lies between three types—piston engines, propeller turbines, and jet turbines. Each of these main types has its special advantages, but to show to its best each must be operated under its own conditions.

The piston aero-engine is in a highly

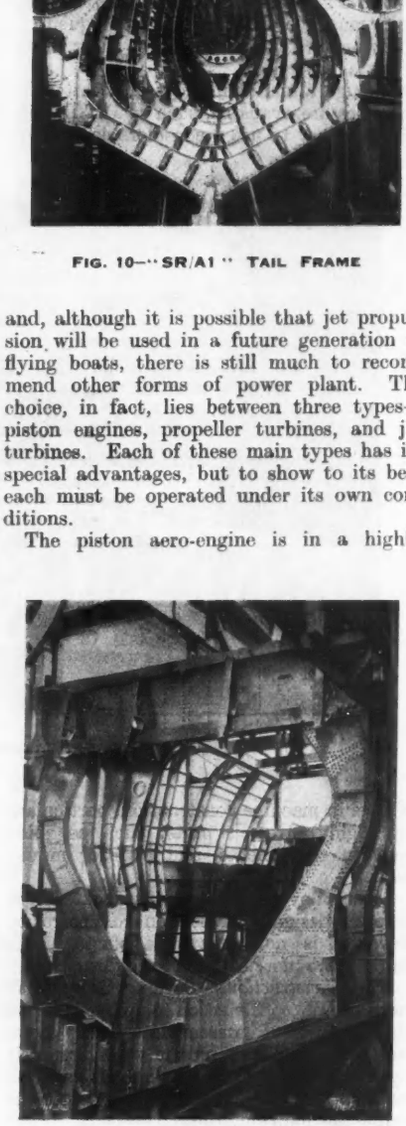


FIG. 11—"SR/A1" MAIN FRAME

developed state, with high power, low consumption, and light weight. Where pay-load alone is the only consideration, it shows up more efficiently than the turbine, but the operating altitude must be low and hence the speed is limited.

The piston engine, for best economy, must be operated on a weak mixture at medium boost and medium speed of revolution. The propeller turbine, on the other hand, shows its best specific consumption at full throttle, high altitude and high speed. The best altitude is governed by the power and wing loadings. It is found that the lowest consumption, and nearly the maximum speed, is obtained at such an altitude that flight takes place at just over maximum L/D speed for the machine when operating at the maximum power permissible for cruising. This altitude will be from 30,000ft to 40,000ft.

The propeller turbine has many advantages for long-range transport. Overweather flight at heights above icing clouds and in steady air conditions justifies a high altitude, although in this case pressurising is necessary. Relatively high speeds on the journey and a high transport efficiency are obtained compared with the piston engine operating at similar heights.

Pure jet turbines, owing to their poor specific consumption, are not suitable for long-range aircraft. The power plant weight, however, is low, and for short journeys at high speed, the combined power and fuel weight are not excessive, compared with the more economical, but relatively heavy, piston engine. For the best performance a high altitude is necessary.

Maintenance.—Flying boats, both military and civil, have a great asset in their capacity for independent operation without requiring base facilities. Because of this they have been invaluable in survey and pioneering flying operation in all parts of the world. This

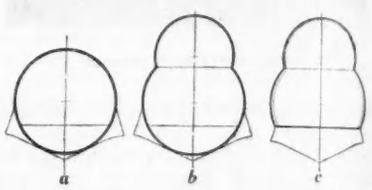


FIG. 12—PRESSURISED HULL FORMS

attribute has, however, been paid for by their having to carry heavy equipment, such as anchors, spares, living quarters for the crew, and so forth, but especially the ease of maintenance has had to be watched, with the result that, generally speaking, flying boats have better facilities for maintenance than landplanes.

Most of this work of inspection and running maintenance had to be carried out at the moorings, usually situated in exposed positions, due to an almost universal lack of docking arrangements.

The size of the hull makes internal work fairly easy, but engine maintenance must be carried out in positions overhanging the water. Various methods have been used for access to the engine. Probably the best is to design the power installation with sufficient room to permit a man to work in the nacelle behind the engine where most of the power services are positioned. Platforms will be required to give access to the front of the engine. These can either be hinged from the leading edge, or can be attached to the wing and nacelle as required. The latter method is probably preferable. Extension platforms are also necessary for reaching the front of the propeller.

In large machines it is usual to provide access to the back of the engines during flight. For this purpose a "crawl-way" is made along the leading edge of the wing, and it is possible to place most of the services in this region. Inspection and maintenance in the wing must be done through close-fitting doors in the top surface.

(To be continued)

Gas Turbine Development in 1946

No. V—*(Continued from page 97, January 24th)*

Other British Firms

The English Electric Company, Ltd., of Willans Works, Rugby, informs us that, during the year under review, it has been carrying out steady fundamental research on gas turbine experimental units, in order to solve many problems affecting the design of units for commercial operation in the marine, industrial and traction fields.

Its programme of investigation is aimed at the production of advanced types of gas turbines, but although prototype units are in hand, the English Electric Company is not yet in a position to publish results.

The General Electric Company, Ltd., of Fraser and Chalmers Engineering Works, Erith, Kent, informs us that during 1946 it has continued to pay special attention to the application of the gas turbine to ship propulsion, particularly with electric transmission. The remarkable progress made with heat-resisting materials during the war has made possible the production of a marine gas turbine with a high economy. The General Electric Company has also studied the application of gas turbines in land power stations, a field which, in its opinion, is of great importance.

The United States

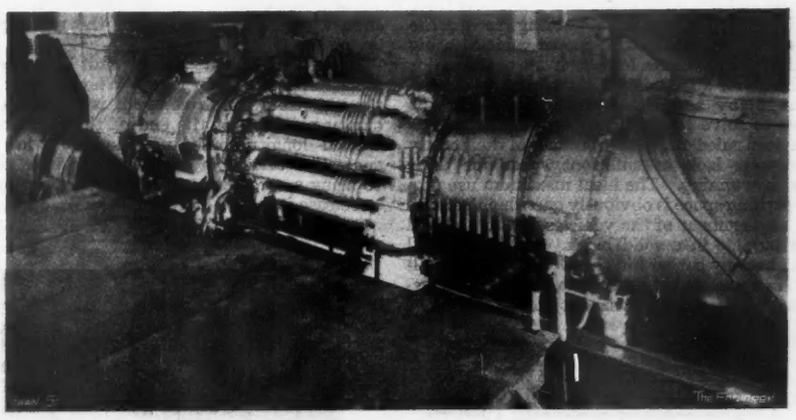
According to our American correspondent the development of the gas turbine in the United States in the year 1946, following some years of interruption by war, was mainly a year of active experiment and research; but it was also a year in which orders were placed for the construction of certain new machines. In the decade, however, which ended with 1946, the gas turbine has had applications for power stations, locomotives, ship propulsion, industrial work and for high-speed aircraft with jet propulsion. Some thirty to forty gas turbines have been in use in America for several years, mainly at oil refineries. Others have been designed for the generation of electrical power, with outputs ranging from 1200 kW to 27,000 kW, and include plans for a plant of 10,000 kW, to be built by the Allis-Chalmers Company. The turbocharger for petrol engines in aircraft consists essentially of a gas turbine driven by the engine exhaust, coupled to a compressor. For such work the turbine blades have to withstand temperatures as high as 1800 deg. Fah., and one line of research has been the development of special metals, designed to withstand the high temperatures involved in turbine operation.

In the United States Navy, several designs of gas turbines have been worked out, and the Allis-Chalmers experimental stationary plant of 3500 h.p. and 1500 deg. Fah. is still under test at the Navy's experiment station. The first application to the merchant marine service is in the conversion of a collier built for the U.S. Maritime Commission, to be equipped with 3300 s.h.p. gas turbines, with reduction gearing and a propeller of the controlled pitch type. Another gas turbine for marine work has been built and put under test by the Elliott Company.

In general, conditions are favourable to the development of the gas turbine, but with certain limitations which are now being studied in order to arrive at a lower cost and a higher efficiency. The field of the gas turbine, however, will, it seems, be to supplement rather than to supersede other forms of prime movers. Designs now in the drawing office or on order include a wide variety of types with varying pressures and mechanical features. As to fuel, both oil and pulverised coal are in use. Plants of closed cycle type can use practically any fuel, but for aircraft propulsion fuels are limited to light distillates. Except for aircraft gas turbines, turbines driving superchargers, and those at oil refineries, this review covers fairly the commercial activity of gas turbine units in the United States. Some definite developments may, however, be noted.

Westinghouse Electric Corporation

An important step in 1946 was the putting into operation, in August, by the Westinghouse Electric Corporation, of an experimental gas turbine generator set of 2000 h.p. Its construction was decided upon in 1943, with a view to obtaining operating experience with a full-size installation, and for this purpose it is of the simplest type of open cycle unit, consisting of a compressor, a combustion chamber, and a turbine. The inlet temperature of the turbine is 1350 deg. Fah., and the expected thermal efficiency for the cycle at full load is 20 per cent. The temperature is considered as the maximum practicable when using the best materials without cooling. In order to compensate for the higher efficiency of more complicated cycles, the combustion chamber was designed to burn a good grade of bunker oil. A view of this 2000 h.p. experimental unit is shown in the accompanying engraving.



Westinghouse 2000 H.P. Experimental Gas Turbine

The air compressor is of the axial-flow type, designed to pass 25,000 cubic feet per minute at a pressure ratio of 5 to 1. The ratio and flow are varied by changing the speed. Air is drawn in and compressed to 30 lb to 75 lb per square inch, according to the load, and is then mixed with the fuel oil and burned in the combustion chamber. The amount of fuel is controlled to limit the temperature of the leaving gases to a range between 700 and 1350 deg. Fah. The hot gases are expanded through the turbine, producing power, and then are exhausted through a diffuser and duct to the atmosphere. The turbine develops 6000 h.p. total, of which 4000 h.p. is used in driving the compressor, leaving 2000 h.p. as useful output, which passes through the gear to the generator. The full-load speed is 9200 r.p.m. for the turbine and compressor, and 1200 r.p.m. for the generator.

The gas turbine has eight stages, designed for equal heat drop over the stationary and rotating blades at the mean diameter. Both sets of blades are of cobalt-chromium-tungsten alloy, unshrouded, tapered and twisted. The rotor is machined from a solid forging of stainless steel, 2ft long and 14½in in diameter. The shaft seals are of the labyrinth type, and the journal bearings of the pressure-lubricated sleeve type. The turbine is connected to the generator through a single-reduction double-helical gear. The unit is stated to run very well and to have quick starting and loading characteristics. It can be brought from standstill to operating speed in one to one and a half minutes. The plant, exclusive of generator, is 26ft long, 3½ft wide and 6ft high.

Gas Turbines for Locomotives

Other interesting developments are under way for gas turbine locomotives in the United States. In one design, the turbine drives a generator supplying current to traction motors on the axles; in another the turbine is geared to the axles. The Pennsylvania Railroad has had one such locomotive in experimental operation since 1944, and it is reported to have two others under construction. All these are oil-burning geared machines. The railways in general are keenly interested in the coal problem, since they consume large quantities of it, and it is among the largest items of their freight traffic. The introduction of a coal-fired gas turbine locomotive is, therefore, of considerable importance, and in 1946 a committee representing a group of railways and a group of coal companies was organised for the development of a gas turbine locomotive using pulverised coal as fuel.

This committee has now ordered the construction of two gas turbine units of 3750 s.h.p. for two experimental locomotives; one by the Allis-Chalmers Company and the other by the Elliott Company. The first will have a twenty-stage compressor and a six-stage reaction turbine operating at 1300 deg. Fah. and 5600 r.p.m., while the second will have a two-stage centrifugal compressor and four-stage turbine with a regenerator, operating at 1275 deg. Fah. and at 6340 revolutions per minute. The frames, cabs, running gears and other parts will be designed and built by three locomotive building concerns, acting in co-

operation. It is expected that the designs will be completed in 1947.

The proposed design is for a locomotive to use an open cycle turbine and electric transmission, for which the thermal cycle efficiency may be about twenty-four per cent, using the equipment now available, and temperatures of 1300 to 1350 deg. Fah. A closed cycle system using a direct-fired air heater is not considered practicable at present, because of the large heat exchangers required and the necessary use of water to cool the air after leaving the turbine so that it can be delivered again to the compressor. With the open cycle, the air is simply exhausted or discharged after it has passed through the turbine and regenerator. The conventional electric direct current transmission is to be used, since equipments for speed control, reversing and regenerative braking are all available with this system. However, when mechanical transmission can be used, with its advantages in lighter weight and higher efficiency, it is likely to supersede the electric transmission.

Much attention is being given to the development of a coal-handling system that can be applied to a locomotive. No equipment is now available for conversion of coal to gas within the space limits of a locomotive and the present programme is to devise a coal-pulverising system with means for fly-ash removal, so that the gas will be clean enough for direct use. Ordinary locomotive coal must be dried, crushed and delivered under pressure at rates up to 8000 lb per hour. It will be fed to the pressure storage tank and thence to a pulverising plant, and then delivered to the combustion chamber at a pressure of about 60 lb. An available pulverising system is the air-operated coal atomiser. On the whole, the present year seems likely to see marked practical developments in the gas turbine as a prime mover in the United States.

Mechanised Car Parking

THE provision of sufficient parking space for the increasing numbers of motor vehicles being used in towns has for long been one of the major problems for all municipal and planning authorities. Many schemes put forward in recent years to solve this problem have on investigation been ruled out, either because of their costly nature or lack of sufficient space for their efficient running. The ideal maximum use of a car parking space is obviously one which permits the arrangement of the vehicles end to end and side by side in a solid block. If the essential fact that any car within the block is to be available in a reasonably short time, such an arrangement is not possible without the use of some mechanical aid. For this reason the "Baldwin-Auger" system of mechanised car parking, designed by Mr. H. Auger, to permit the maximum use of available space, has been introduced by Building, Engineering and Mechanics, Ltd., 20, Harcourt House, 19, Cavendish Square, London, W.1. We recently had an opportunity of inspecting a prototype unit of the new system, which is now in successful operation at the Fraser and Chalmers Engineering Works at Erith.

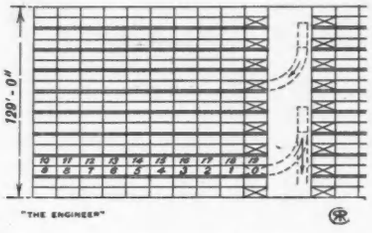


FIG. 1—MECHANISED CAR PARK

A typical arrangement of a car park laid down on the new system is to be seen in the diagram Fig. 1. Such a park can be set below, on or above street level, or arranged on a series of superimposed floors in one building. In it the vehicles are parked end to end and side by side in two groups, one on each side of a central driveway. The parking space in each group is divided into a series of mechanical units, each of which handles two adjoining ranks of cars disposed longitudinally. In order to clarify the method of operation we will deal with the single mechanical unit containing vehicles numbered 1 to 19 on the diagram. It will be noted that when the unit is full there is one vehicle space less than the number of parking spaces available. This empty space 0 is always left at the end of one line in a unit in order to permit circulation of vehicles within the rectangular lay-out.

Each vehicle in the parking unit is carried on a platform set at floor level. When a car enters the unit from the driveway it is run on to an empty platform at the end of the unit and is carried longitudinally up the line with the successive arrival of other vehicles. In order to bring a car down to the relative position 19 to release it from a fully packed unit, a series of mechanical movements, effected by means to be described later, are imparted to the platforms carrying the cars. It will be assumed that the vehicle on platform No. 10 is required. A selector switch is pressed at the control centre and the platform of No. 19 traverses over to the vacant position 0, the whole line of vehicle platforms 10 to 18 then moving up to put platform 18 where No. 19 was originally situated. Platform No. 9 then moves over to the position vacated by platform 10 and the whole line of platforms 19 to 8 moves up to fill the position vacated by No. 9. Then platform 18 crosses over to the space vacated by No. 19 at the bottom of the adjoining line. This series of platform movements continues until the platform No. 10 carrying the required vehicle is in the space, adjoining the driveway, which was originally occupied by platform No. 19, whence it can be driven away.

Although this sequence of movements would appear to take a fairly considerable amount of time, it is actually relatively brief, as each individual movement in the cycle is designed to take only about forty seconds. The average time to obtain a car from the furthermost position in a line of ten platforms is stated to be only about six minutes. It should also be pointed out that the mechanical sequence of movements works in either direction and is automatically operated in the direction of rotation which will set a platform in a position adjoining the driveway in the shortest possible time, involving the fewest series of movements.

Parking units are to be made in three sizes having platforms to accommodate small, medium and large vehicles. A large park laid down on this system would contain a suitable selection of each size of unit to permit the economic handling of vehicles in proportion to their weight and size. When cars are being driven into an empty park or on to a clear unit they can proceed under their own power over to the floor level platforms to appropriate positions on the mechanical units.

The design and lay-out of the operating mechanism developed for the system is particularly interesting, and we reproduce herewith some photographs of the principal points in a unit. Each unit is in the form of two pairs of continuous steel gratings, each 24in wide and running longitudinally the full length of the site. Each pair of gratings is divided into sections of appropriate length to accommodate a car, and although the two sections of grating forming one platform are not directly connected, their moving sequence is such that they are always in exactly the same relative positions at any point in the system. The platforms are connected longitudinally by automatic couplings at each end of each length of grating to form a continuous train. Between each end of the two lines of platforms forming a unit is a traversing or cross-over mechanism. This mechanism is arranged to carry a platform with its load from one line to the next in either direction. Along the lower longitudinal edge of each grating is welded a rolled steel joist, which supports it on rollers running in steel channels set below the floor level along the full length of the unit between the traversing points.

FIG. 2—VEHICLES DRIVING ON TO AN EMPTY PARKING UNIT

As will be appreciated, the drive to each line of platforms, in addition to being positive according to their length, in order that they shall be set correctly upon the traversing gear, has also to be rapid to maintain the close time cycle upon which successful operation of the mechanism is based. This driving mechanism is designed to move each line of platforms an exact distance in ten seconds from start to stop, and is based upon what the makers term a "modulator."

A modulator is set below floor level in a pit between the two lines of each series of platforms. The two modulators used on a unit are driven by a common shaft extending from an electric motor below the floor level on one

side of the unit. A 12 h.p. squirrel-cage motor has sufficient power to drive the modulators of a unit designed to accommodate nineteen medium-sized vehicles. The two modulators of a parking unit can be seen in the photograph reproduced in Fig. 3 and the diagram Fig. 4. At each end of the modulator frame is a sprocket wheel, over which passes an endless chain. The pins of this chain project on either side to engage and support the carriage on a rack cut

carriage. The combined movements of the collector plate and carriage thereby impart a rapid acceleration up to a maximum speed, which is maintained until the plate approaches the far end of the carriage, where rapid deceleration takes place until movement imparted by the main driving chain ceases.

Link rods extending from the collector plate of the modulator are designed to spring catch pins into sockets below the platform plates

in exact alignment and longitudinal relationship. The carriage is mounted on rollers running in guide channels across the width of the unit and it is driven through chains by a second 1½ h.p. motor. In operation, the carriage with its load traverses across the space between one platform line and the next, carrying the pair of gratings with their load over the retracted sections of floor. When the gratings are in their new alignment the floor sections again rise to

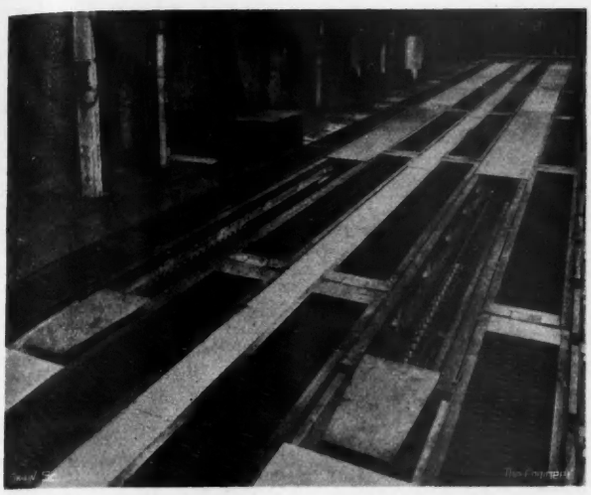


FIG. 3—"MODULATOR" WITH COVER REMOVED

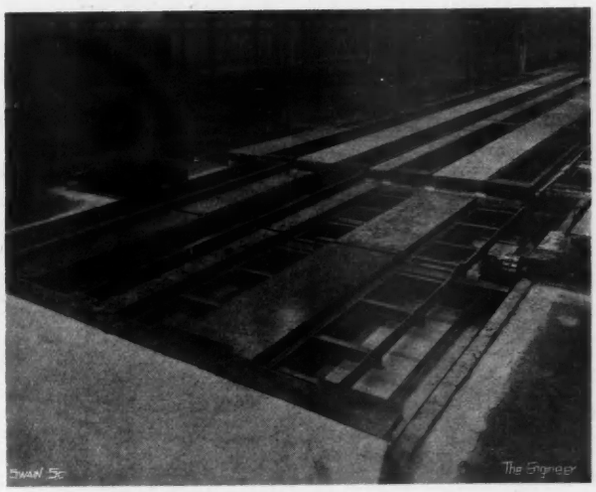


FIG. 5—TRAVERSING STATION WITH FLOOR SECTIONS RETRACTED

along a steel channel fixed at the bottom of the pit. Along one side of the pit extends a chain driven through sprockets by the main shaft. A pin projecting from the side of this chain is arranged to engage the two-way haulage mechanism of the modulator carriage and draw the assembly along the pit. This haulage mechanism is so designed that the modulator can be moved in either direction under load and incorporates an over-run which eliminates the necessity to fit heavy braking gear on the main motor.

What is known as a collector plate is linked

prior to movement taking place. When the modulator of one line of platforms is switched on and its catch pins engage, the corresponding link rods on the other modulator actuate spring locking pins which anchor the platforms of the adjacent line to prevent movement.

At the traversing stations at each end of a unit, one of which can be seen in Fig. 5, the sections of floor carrying the platform rails are supported on a framework situated in a pit below floor level. A system of levers supports these floor sections on their framework in position level with the platforms and surround-

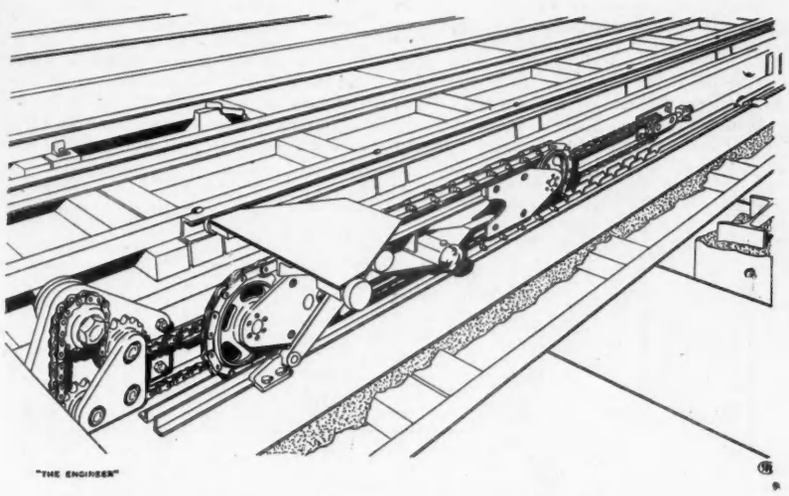


FIG. 4—DIAGRAM OF "MODULATOR" ASSEMBLY

on to the topmost run of chain on the modulator carriage and it is through this plate that final drive is transmitted to the platform lines. When power is switched on to drive the modulator the carriage begins to move along the track, and within a short distance the chain of the carriage begins to rotate by virtue of the action of the fixed rack on the projecting pins. Rotation of the carriage chain carries the collector plate towards the opposite end of the

ing floor area. This lever system is actuated by a 1½ h.p. electric motor. At the start of a traversing movement it is retracted to drop the frame and floor sections to a depth of 6in below the ground level. As the floor sections with their supporting rails recede, the two platform gratings are supported at three points along their lengths by a separate carriage. The supports on this carriage are designed to maintain the two gratings with the load they carry

support the platform in its new position ready for a longitudinal movement of the line to remove it. The couplings at the ends of the gratings are of the horizontal sliding male and female type, which are automatically coupled and lined up when traversing is completed.

The driving gear of the cross traverse mechanism is interlocked with the modulator catch gear so that the train of platforms selected for movement can only travel in a direction on either line in which there is the vacant space to accept the platform.

The whole of the mechanism is operated in its sequence through a straightforward electrical relay system from a central station which is designed to control any reasonable number of units in a parking block. All parts throughout the system are interlocked, and failure at any point automatically stops the complete unit.

Despite the number of movements entailed in bringing a selected platform forwards from a rearwards position, the time actually taken, between vehicle selection and availability is, as we were able to witness at the demonstration, remarkably short.

We are informed that the system can be installed on level existing area, providing that existing columns or stanchions are pitched at not less than 16ft centres, and that three pits of about 2ft depth can be excavated for the modulators and the traversing gear. The platforms with their support rails and false flooring are built upon pre-cast concrete units.

In conjunction with this system equipment has been developed to ensure by automatic means that no vehicle beyond the capacity of the platforms can be accepted for storage. Other means ensure also that each vehicle shall be set upon its platform without overhang or projection due to bad positioning by the driver.

Although this system has been developed for the parking of vehicles, it is evident that it has a wide field of application in the storage and warehousing of materials. In a majority of storage establishments a considerable amount of space is wanted on gangways, particularly in those handling relatively small quantities in wide varieties, all of which have to be immediately available upon demand. In such establishments where the required bulk of goods could be quickly brought to a central roadway, for removal by cranes or other lifting appliances straight on to trucks, considerable time and manhandling could be saved as well as space.

Metallurgical Topics

Precipitation-Hardening Stainless Steels

It has long been known that the addition of 2 per cent or more of titanium and the use of proper heat treatment produce precipitation-hardening in 18 : 8 chromium-nickel steels.[1] Some light is thrown on this process and the development by the Carnegie Illinois Steel Corporation of a more suitable composition for this type of precipitation-hardening stainless steel (called Stainless W) is described in a paper by R. Smith, E. H. Wyche and W. W. Gorr.[2]

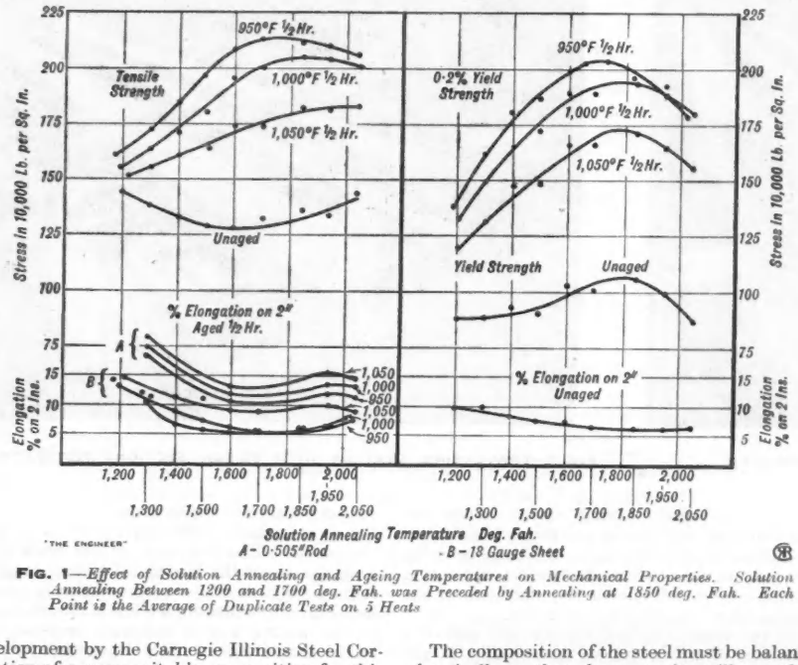


FIG. 1—*Effect of Solution Annealing and Ageing Temperatures on Mechanical Properties. Solution Annealing Between 1200 and 1700 deg. Fah. was Preceded by Annealing at 1850 deg. Fah. Each Point is the Average of Duplicate Tests on 5 Heats*

In this steel, which has the following approximate composition, titanium is the element primarily involved in the precipitation :—

	Per cent.		Per cent.
Carbon	0·07	Nickel	7·0
Silicon	0·50	Chromium... ...	17·0
Manganese	0·50	Titanium	0·7
Sulphur	0·010	Aluminium ...	0·2
Phosphorus	0·010	Iron	Balance

With this composition austenite is stable at elevated temperatures and ferrite at room temperature. The hardening constituents are soluble in austenite, but are relatively insoluble in ferrite. Precipitation-hardening is brought about by reheating the supersaturated ferrite to a moderately elevated temperature below that at which it transforms to austenite. Although the precipitation has not been observed microscopically with certainty, more positive proof has been obtained from X-ray diffraction data, and by dilatometric and other physical tests. The simplest proof that the precipitation occurs in the ferrite is that the degree of precipitation-hardening is approximately proportional to the attraction of a hand magnet prior to ageing.

The composition of the steel must be balanced chemically so that the austenite will transform to ferrite on cooling. The transformation which is essential to the precipitation-hardening usually begins at about 125 deg. Cent. and is practically complete in from two to four hours after the material has been cooled to room temperature. If the amount of any of the elements is varied in such a way as partially to suppress the transformation of austenite to ferrite, only a limited precipitation-hardening is possible. The degree of hardening may be controlled by purposely adjusting the composition so as to prevent some of the austenite from transforming to ferrite.

The most important element is the titanium which is not only the primary cause of the precipitation-hardening, but is also a strong ferrite former. With all other elements properly balanced the best percentage of titanium is in the range 0·4 to 1·0 per cent. If lower, the matrix will remain partially austenitic. If higher, the hardening will be excessive and the ductility low, unless a lower solution-treatment temperature or a higher ageing temperature is employed.

Aluminium is added as a deoxidiser with an excess which remains in solid solution and serves to augment the titanium as a ferrite former and possibly in the precipitation also. Carbon, if too high, combines with some of the titanium, which is then no longer able to take part in the precipitation-hardening reaction. Nitrogen behaves like carbon by combining with and immobilising the titanium. If nickel is lowered to 5 or 6 per cent both ductility and corrosion resistance are impaired. As the nickel content is raised the stability of the austenite increases, but since the precipitation-hardening does not occur in austenite the final hardness diminishes. The nickel is replaceable to some extent by copper. To maintain corrosion resistance the chromium content should not be less than 17 per cent.

Silicon was used as a preliminary deoxidiser. Up to 2 per cent it had little influence on the hardening effect, but as a mild ferrite former it has a bearing on the austenite-ferrite ratio. Manganese can be raised if nickel is lowered. Columbium (niobium) has been substituted successfully for titanium to produce precipitation.

On heating a steel of the composition quoted above the ferrite begins to transform to austenite at approximately 565 deg. Cent. and on cooling in air the austenite-ferrite transformation begins at about 125 deg. Cent., but is sluggish. The solution-annealing may be at any temperature between 1200 deg. and 2000 deg. Fah. (650 deg. and 1095 deg. Cent.). Heating for five minutes at the higher temperatures is enough. If the solution-annealing temperature is below 925 deg. Cent. the time must be longer. Precipitation or ageing takes place over a range of reheating temperatures between 260 deg. and 565 deg. Cent., being slower at the lower temperatures. A time of fifteen to thirty minutes at 510 deg. Cent. is suitable. The precipitation starts very rapidly and 60 per cent of the increase in hardness is obtained after only one minute at 510 deg. Cent.

Water cooling of the steel from the ageing temperature gives much improved impact values over those obtained after air cooling. The effect of annealing temperature and of time and temperature of the ageing treatment is shown in the diagrams Figs. 1 to 3.

The treatment recommended is to heat at 1040 deg. Cent. for half an hour, cool in air and after two to four hours at room temperature to reheat to 510 deg. Cent. for half an hour and cool in water.

In the original paper extensive series of tests are reported, not only the ordinary mechanical tests at room temperature which are summarised in Fig. 1, but impact, tensile and fatigue tests at

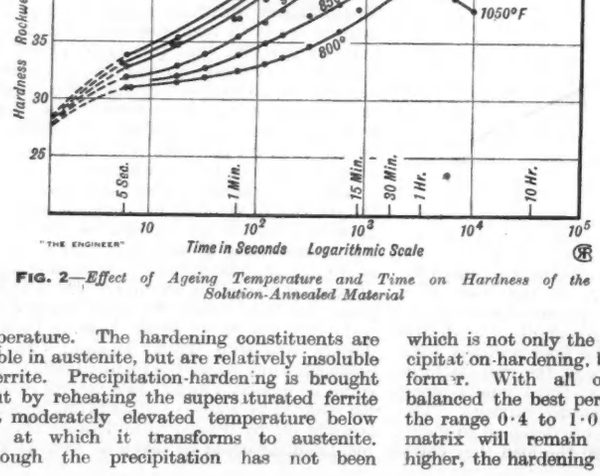


FIG. 2—*Effect of Ageing Temperature and Time on Hardness of the Solution-Annealed Material*

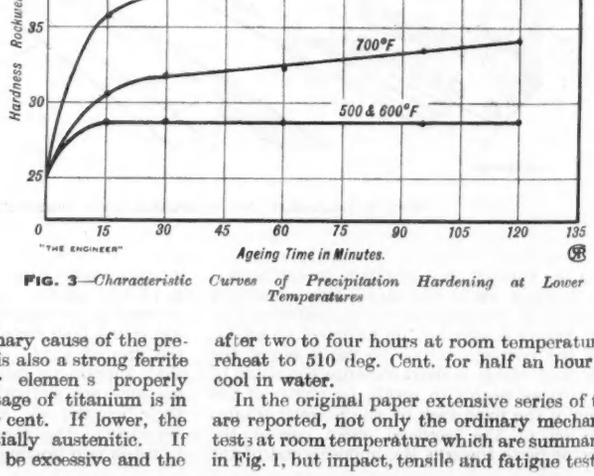


FIG. 3—*Characteristic Curves of Precipitation Hardening at Lower Temperatures*

raised temperatures, weldability and corrosion tests, &c.

In properties the steel compares more nearly with 17 per cent chromium steel than with austenitic 18 : 8. Its strength at temperatures of 315 deg. to 430 deg. Cent. is about the same as that of 18 : 8, though below 300 deg. Cent. its strength is similar to that of cold-worked 18 : 8 in the fully hard condition. The steel is readily weldable and its corrosion resistance in mild corrosive conditions is equivalent to that of 18 : 8.

[1] J. S. Marsh : "The Alloys of Iron and Nickel," Vol. 1 (1938), pages 465–468.

[2] *Metals Technology*, 1946, Vol. 13, June. Amer. Inst. Min. Met. Eng. Techn. Publication, No. 2006.

New Developments in Bearing Metals

THE course of the development of bearing metals during the last few years has been largely governed by economic considerations arising from the scarcity of certain metals, and by the more severe conditions which bearings are now called upon to meet in the automobile and aircraft industries. Mr. O. W. Ellis, Director of Metallurgical Research in the Ontario Research Foundation, has discussed "New Developments in Bearing Metals" in a recent paper[1] in which, after summarising the essential properties of a bearing metal, he considers the different types with their wartime modifications in detail. The paper naturally deals mainly with developments in Canada and the U.S.A.

Tin-Base and Lead-Base Alloys

In resistance to corrosion by organic acids derived from the lubricating oil the tin-base Babbitts are superior to the lead-base bearing metals which replaced them owing to the scarcity of tin resulting from the Japanese occupation of Malaya, but the properties of the lead-base alloys are nevertheless good in properly designed bearings. The principal American alloys now in use are S.A.E. 14, which is 75 : 15 : 10 lead-antimony-tin with 0·5 per cent of arsenic to improve its properties at raised temperatures, and S.A.E. 15, containing approximately 83 : 15 : 1 : 1 lead-antimony-tin-arsenic with permitted copper up to 0·5 per cent.

Fatigue failures are perhaps the main danger to be guarded against. Before 1934 fatigue failures in bearings were almost universally attributed to poor bonding between the material and its backing. Since that date (largely owing to the work of Macnaughtan and other work sponsored by the International Tin Research Council) the importance of fatigue has been fully recognised. It has, however, been found that the tendency for fatigue cracks to form is counteracted by the simple means of decreasing the thickness of metal in the bearing. In a tin-Babbitt the following improvement in the life of the bearing metal resulted from decreasing the thickness :—

Thickness, inch.	Relative life.
0·030	1·0
0·020	1·0
0·010	1·5
0·005	3·2
0·003	4·6

Other data supporting this conclusion are given in Mr. Ellis's paper, but unfortunately it is easier to demonstrate the advantage of reduced thickness than to produce uniformly thin layers of bearing metals economically.

The solution of the problem of manufacture of the very large number and variety of bi-metal bearings now in use has been found in the production of bi-metal strip. In a continuous process, steel strip is etched anodically and rinsed, fluxed and tinned with a layer of pure tin, 0·00005in thick. The tinned strip then passes through rolls designed to put a camber on the strip as it passes through the pouring box, causing its edges to rub against the box and so prevent leakage of the molten alloy poured on to the strip at a rate regulated to give a layer 0·060in to 0·070in thick. On leaving the casting box the strip is cooled on the underside by cold-water spray, cleaned by a high-speed brush and the thickness of the alloy layer reduced to about 0·02in by means of a milling cutter.

Cadmium-Base Alloys

But for the limited supply of cadmium the use of alloys containing more than 98·25 per cent cadmium with either nickel or silver in small quantities might have been extended because of their superior resistance to fatigue. The nickel alloy is said to give a better bond to steel. It has been proposed to improve their corrosion resistance by electrodeposition of a thin layer of indium followed by a diffusion heat treatment.

Copper-Base Alloys

In view of the tin shortage, two tin-free alloys, principally applied in automobiles and aircraft, are given by Ellis, viz.:—

	S.A.E. 48. Per cent.	S.A.E. 480. Per cent.
Copper	67·0 to 74·0	60·0 to 70·0
Lead	25·0 to 32·0	30·0 to 40·0
	With silver up to 1·5	With phosphorus up to 0·35

Copper-lead alloys with about 30 per cent lead and 3 per cent silver are found in service in the automobile industry. Tri-metal bearings with a steel backing, a 75 : 25 copper-lead intermediate layer (0·01in to 0·03in thick) and a lead-tin overlay (about 0·002in thick) are also in use.

Copper-Nickel

It has long been known that 2½ per cent of nickel can be substituted for tin in the 80 : 10 : 10 copper-tin-lead alloy. Acute shortage of tin led to the development of interesting alloys having a copper-nickel base. The Welland Iron and Bronze Company developed an alloy in which the 10 per cent of tin was replaced by nickel 8 and antimony 2 per cent. J. T. Eash, of the International Nickel Company, showed that the alloy containing nickel 8, tin 2, antimony 1 and lead 10 per cent was a promising substitute for 80 : 10 : 10 copper-tin-lead in the cast condition. It wears better and has a higher yield point, but rather lower ductility. If the 2 per cent of tin is omitted the yield point falls by 30 per cent, rendering the alloy unsuitable for use where relatively high bearing pressures are likely.

Silver

Among the most interesting developments are the plated triplex bearings recently developed for the aircraft industry. These consist of steel shells electrodeposited with silver, which is then machined to very close dimensional tolerances and finally plated to size with lead and then with tin or indium. They are later annealed under carefully controlled conditions to bring about diffusion of the indium or tin and lead.

This type of bearing surpasses all others in its uniformity, both metallurgical and dimensional, fatigue strength and load-carrying capacity. Silver alone sometimes shows a tendency to seize, but the soft overlay to these bearings completely overcomes the trouble. The thickness of the diffused layer is only 0·00075in to 0·0015in ; thicker deposits would fatigue too rapidly. Dirty oil and high operating temperatures considerably reduce the life of this type of bearing.

Aluminium Alloys

The rather brief reference made by Ellis to these alloys can be supplemented by information given about them in other recent American reviews of progress.[2, 3]

Before 1939 aluminium alloys rich in tin and containing smaller amounts of such elements as copper, nickel, manganese, antimony or magnesium had been investigated and some of these were in use for connecting-rod and main bearings of Rolls-Royce products. American experience confirmed the opinion that they could only be used under moderate bearing pressures and temperatures with hardened shafts and good lubrication. Developments in America have been in the direction of (1) modified composition of solid aluminium alloy bearings to improve their properties (2) bonding of aluminium-tin to a steel backing in order to overcome the somewhat unsatisfactory load-carrying and fatigue characteristics of the aluminium alloys for heavy duty service, and (3) production of aluminium alloy bearings by powder metallurgy technique.

Two cast alloys of similar properties have been developed by the Aluminum Company, of America, the second being used also in the wrought condition. They contain :—

	Mark 750.	Mark A750
Tin	6·5	6·5
Nickel	1·0	0·5
Copper	1·0	1·0
Silicon	—	2·5
Aluminium	Balance	Balance

These alloys have good corrosion resistance. Their mechanical properties and design characteristics, determined by H. Y. Hunsicker and L. W. Kempf, are given by Woldman[3] in some detail, in comparison with those of other bearing metals, indicating their higher yield point and tensile strength, fatigue limit and maximum allowable operating pressure.

Though the information given by Ellis about the aluminium alloy bearing metals might have been considerably expanded he seems to be entirely justified in summing up the position to the effect that the aluminium alloy bearings hold promise of considerable future success, but that at present they can be run only against hard journals (300 Brinell and over), require a large volume of cool oil to keep the temperature below 275 deg. Fah., call for large running clearances and need special protection from grit and dirt ; whilst other problems confronting the engineer in the use of these alloys as bearing metals are connected with their thermal expansibility and bonding characteristics.

[1] O. W. Ellis : "Trans.," Can. Inst. Min. Met., 49 (1946), 447–465. (Canadian Mining and Metallurgical Bulletin, September, 1946.)

[2] H. R. Clauser : "Aluminum Alloy Bearings for Heavy Duty Applications," *Materials and Methods*, 24 (September, 1946), 633.

[3] N. E. Woldman : "Characteristics of Aluminum Bearings," *Iron Age*, 158 (September 12, 1946), 60.

L'Association Technique de Fonderie.—Welcome evidence of the resolution with which the French industrial and technical societies are freeing themselves from the restrictions consequent upon the war and the German occupation of France is afforded by the fact that the Twentieth Congress of the Association Technique de Fonderie, held on October 18 and 19, 1946, was truly international in character. Of the 300 who attended, about 50 came from outside France, and of the fourteen papers communicated to the Congress, six originated abroad. Three were exchange papers (from America, Belgium and Great Britain), two were from Czechoslovakia and one from Switzerland. The "Proceedings" of the Congress will be published shortly in a special number of *Fonderie*, the monthly review issued by the Association in conjunction with the advisory body, Centre Technique, de la Fonderie.

Powder Metallurgy.—An article on "Metallic Powders," by Dr. H. Lacoste, in *La Métallurgie*, November, 1946, pages 15–21, takes the form of an abstract and review of some of the work of Kieffer and Hotop, Skaupy and Hoffmann, Williams and Price, Wulff, W. D. Jones and others. It deals with the preparation of metal powders by mechanical and by physico-chemical methods, such as reduction, deposition from the gaseous phase and electrolysis ; and records the chemical and physico-chemical properties of a variety of metallic powders. No details are given of the mechanical properties of the sintered compacts. The paper deals with the properties of the metal powders and not with those of the finished products, but after mentioning a large number of applications of powder metallurgy to the manufacture of components used in mechanical engineering, and in the chemical and electrical industries, the author concludes by saying that a large field of application is open to powder metallurgy, especially in France at a time when the lack of primary materials is so severely felt.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER, *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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GAS TURBINES AND THE NAVY

IN the past the Admiralty has often led the way in the development of marine machinery by providing tests on the full scale for new kinds of plant. The first Parsons marine turbines, for instance, exclusive of those in the famous "Turbinia," were installed in the destroyers H.M.S. "Viper" and H.M.S. "Cobra." Though, unhappily, both were wrecked soon after entering service, those ships did enough to prove the practical virtues of their propelling machinery, and there can be little doubt that without the experience so gained and the confidence engendered by further naval support the development of steam turbine propelling machinery in the Merchant Navy would have been less rapid. In a similar way the Admiralty desire to use geared machinery resulted in continued encouragement of the improvement of gear-cutting machinery with general benefit to industry at large. Naval boiler design has, perhaps, had a less direct influence on marine steam generators in general. For normal mercantile needs in this kind of plant do not wholly correspond with those of naval vessels. But it can hardly be doubted that progress would have been less rapid without the encouragement boiler manufacturers received from the Admiralty, even if for a few years between the wars naval men seemed for a time less receptive to new ideas than they had been in the past. On the reverse side of the picture it may be speculated that one of the reasons why British oil engine builders failed to gain a lead in the marine field was a consequence of the fact that the Navy, apart from plant for submarines, a rather specialised application, showed little interest in that prime mover. We are disposed to wonder, too, whether, had our Navy shown as much interest in electric propulsion as did the U.S. Navy, that form of drive might not by now be more prevalent amongst merchant ships built in this country. The fact that the Admiralty is, thus early, taking a keen interest in the development of marine gas turbines and is encouraging research and intends to provide facilities for full-scale trials may thus be taken to augur well for the future of that prime mover at sea.

The Admiralty announcement which we print on another page of this issue indicates that the Navy is at present interested, in particular, in two separate forms of the gas turbine. The less important object is the design of machinery for fast coastal craft based upon aircraft gas turbine practice. But for marine applications in general the work in hand upon the development of machinery suitable for an escort vessel seems to be of greater value. For, presumably, this machinery, unless it proves unexpectedly unsatisfactory, will be but the precursor of larger plant for heavier ships. The installation, besides providing manufacturers with practical experience of performance at sea, may provide some indication of the best means of solving such a problem as, for instance, that of reversal. It will also give naval men experience in the operation of such plant, a point of no small importance, since unsatisfactory results with new devices can often be traced, not to ineffective design, but to faulty handling by crews unfamiliar with their characteristics and sometimes, indeed, hostile to their introduction. Some of the advantages that the Navy hopes to reap eventually from the use of gas turbine machinery in warships are listed in the announcement. The turbine is expected to share to some extent with the oil engine the ability to develop full power very rapidly from a cold start. It is believed that for the same output it will prove less bulky and lighter than steam machinery, an advantage that may, however, be counterbalanced by a lower economy in usage of fuel unless thermal efficiencies can be raised. Further, it is expected to prove simpler than steam machinery and, presumably because of its smaller bulk, less vulnerable to enemy action. Some of these advantages may well appeal also to designers of ordinary merchant vessels.

As a result of experience with aircraft engines enough is already known for a designer to feel confident that a projected marine or industrial gas turbine will operate and generate power at or near its intended efficiency. Enough, too, has been accomplished with aircraft plant to demonstrate how inherently high is the reliability of the gas turbine mechanism. It is said, for instance, that in "flying test beds" interruptions to the test programme are at least as likely to occur through minor faults in the conventional reciprocating engines as through the failures of the experimental turbines under test. But the life of an aircraft engine need only be reckoned in hundreds of hours, whereas marine and industrial plants must be designed for lives at least ten times as long. Moreover, marine and industrial plants, exclusive of those intended for such work as the propulsion of coastal craft, will need to be designed eventually for very much larger power outputs. Mere size alone, apart from other factors, can introduce problems of heat flow and expansion and of centrifugal stresses and vibration very much more serious than those likely to be encountered in smaller aircraft plants. Furthermore, for naval work the design may well prove to be further complicated by the need to combine reasonable economy at very high outputs with high economy at low outputs, a characteristic distinctively different from that called for in the operation of mercantile ships. As is well known, research into such problems and many others connected with detail design is being undertaken by PAMETRADA. The work of that organisation and of the National Gas Turbine Research Establishment is now receiving the support of the Admiralty. If past experience can safely be accepted as a true guide to the future, the work of these bodies, in conjunction with the full-scale tests that the Admiralty can provide, may confidently be expected to place this country in a leading position in the construction of marine gas turbines. It may well, too, have beneficial repercussions on the design and construction of industrial land plants, a field of endeavour in which at present British firms lag behind their Continental competitors.

MECHANISATION OF THE RUHR COLLIERIES

IN our issue of June 21st, last year, we had occasion to review Volume I of the Technical Report on the Ruhr Coalfield to the Ministry of Fuel and Power, made by the Mission appointed by the Minister for that purpose. That volume consisted of the text of the report. In our review we regretted the absence from the report of illustrations and appendices to which frequent references were made, and which are necessary in several instances to the complete comprehension and importance to some of the particular subjects dealt with, these diagrams being relegated to Volumes II and III, which had not then appeared. Nearly six months having elapsed, Volume II, covering the illustrations, has now been issued, but Volume III, containing the Appendices 1–30, and reports of investigating teams of specialists organised on the basis of the Mission's recommendations, has not yet been published. It should contain matter of especial interest to mining engineers. Volume II is divided into two parts; Part I of interleaved pages of figures; Part II, consisting of separate sheets contained in a pocket or wallet, comprising chiefly plans of layouts of mines, colliery shafts, skip winding, surface arrangements, &c. We have the criticism to offer regarding the manner or form of the presentation of the illustrations to the text, that seeing reference in the text to the figures is in regular sequence, the figures do not appear in sequence in the two parts. To give an instance, in Part I we find Figure 171 followed by Figure 191: for the intervening twenty figures we have to refer to Part II. There are a number of such gaps. Whilst, undoubtedly, fairly large-scale plans will

prove of use to the mining engineer who is anxious to put any one of the arrangements into practice at his own colliery, it seems to us it would have made for convenience if the illustrations had been contained in one volume without a wallet for a number of loose, detached sheets. However, referring as it does to a point of convenience in reference, that may be regarded as a minor matter.

A detailed review of this interesting sequel to the text of the report is impossible within the bounds imposed by the exigencies of our space, but some of the more important or novel of the figures may be touched upon. For, whilst to the well-informed British mining engineer there is, perhaps, little that is new, there are some plants which are uncommon in, or entirely absent from, our coal mines, such, for instance, as the mechanical packing machine. Packing of mine wastes by hydraulic, pneumatic and machine methods has proved practicable and economic at many continental collieries, but at only some few collieries in Great Britain has the hydraulic method been practised or found economic, for the reasons advanced by Herr K. Seidl, a German expert on the subject, in his report to the Spontaneous Combustion in Mines Committee in 1921. But pneumatic and mechanical processes of stowage were not anywhere in operation at that time, either in Great Britain or on the Continent. Looked at from the point of view of the prevention, or, at any rate, the reduction of subsidence, the mechanical stowage of wastes would not provide the compressive force necessary to give compactness to the packing-in of the wastes, so as to act as a preventive of, or of liability to either spontaneous combustion or of subsidence of the surface. Mechanical packing, however, might prove economically practicable as ordinary stowage in the case of longwall faces where there is ample packing material available, and where spontaneous combustion and prevention or limitation of subsidence are not important factors. It is to be observed—perhaps because of the reasons we have suggested—that mechanical packing in the Ruhr is applied only to 2 per cent as against 13 per cent pneumatic and 10 per cent hydraulic stowage in the case of seams of 25 deg. inclination and under. As we remarked in our previous article on the subject of the Ruhr coalfield, coal cutters in point of design are basically the same as those in use at our own collieries. The Germans are, as, indeed, we in Britain are also, making considerable advances in face power loaders, judging from a study of the drawings of the coal plough, particularly in what is termed the "resonance tractor machine." This tractor travels fast when the resistance to it is low, but slows up and pushes harder when the resistance increases, which, as the report states is a basic requirement of a good coal plough. The "resonance machine" had not yet, however, at the time the report was written, been given a practical trial, owing to lack of certain components. We in Britain are in much the same position. It will be interesting to see which will take the lead in the mechanical loading of coal at the face. When we come to the consideration of the subject of underground haulage in the Ruhr one realises from Fig. 1 in Part II that, owing to the wavy character of the strata, the only proper way would be, as they do, to drive level haulage roads through the measures instead of adhering to the seam, and though it would not be economic or good practice in the case of many of our collieries, where the inclination of the seams is moderate and not subject to variations, in other respects the haulage arrangements in the Ruhr field constitute, perhaps, the more interesting and novel features of the report and should receive the close study of British mining engineers. The haulage plans are of peculiar value: thus, at the Hanover mine, Fig. 314 of Part II, from which very large outputs are obtained, only twenty-three shifts per 1000 tons were worked on the main haulage during the month of May, 1944, compared with forty-six for the whole of the Ruhr. In spite of the fact that the very high-powered electric locomotive (which is the principal advantage of the trolley system) is not employed in the Ruhr, the trolley system is there the most popular of underground haulages, and is replacing the diesel locomotive. The compressed air locomotive—which, incidentally, was in operation for a long time, many years ago, at a Durham colliery—still exists at a number of mines in the Ruhr. Though the trolley system is not unknown to British mines, it is not permissible in any gassy mine. Figs. 69 and 70, Part I, and 71 and 72, Part II, show in detail the arrangements in respect of the short-circuiting switch by which the driver of the locomotive can make the trolley wire instantly dead in the event of any emergency—we are told that this "functions well and with complete safety." The maximum load on the trolley wire, however, it must be remembered, in the Ruhr, seldom exceeds 400 kW. As to the sources of power supply, there seems to be little that is novel or new. Direct current at 250 volts has become standard practice for trolley locomotives. The generating plant has taken the form of rotary converters, motor generator sets being now at a few plants only; and few installations—and these only of recent origin—are equipped with glass bulb or steel tank mercury arc rectifiers. It would appear that in the matter of power supply we have nothing to learn from the Ruhr. In fact, in this respect we are probably the first in the world.

In winding and shaft layout, although the Koepe system has been known to British mining engineers for many years, there are details which have been evolved during its long use in Germany depicted in the report which will be of value to those who contemplate its installation at our deep shafts. This winder has largely displaced other types in the Ruhr, and has given great satisfaction, being less expensive to install and operate than the ordinary drum winder. In the rope groove linings of the Koepe pulley, the use of oak and elm wood is common, taking the form of insets in a dovetailed groove in shaped wooden blocks bolted to the rim of the pulley. Other linings with a higher co-efficient of friction are also employed; cemented in alternate layers, the use of soft and chrome leather appears to be increasing. Aluminium has the highest co-efficient of friction but is inclined to flake off. The minimum co-efficient required by regulation is two, but the materials normally used have a much higher co-efficient, and there appears to be practically no slip when winding from a depth of 2000ft or more, with a load of 10 to 14 tons. As one would have presumed, slip is more apparent when winding from shallow depths or with lighter loads. The diameter of the pulley should be 100 times that of the rope and 2000 times that of one wire. The surface layout of Ruhr collieries has for long been noted for its excellence. The plan shown by Fig. 173, Part II, is a case in point, being that of the recently developed Walsum mine, with a capacity of 12,000 tons a day. Fig. 174 illustrates some of the surface buildings at another modern mine. The surface layout of these collieries strikes one as being on a par with that of a large modern British colliery. In the cleaning of coal and its preparation for the market, not only have the Germans led the way, but the French and Belgians also have excelled in the design of coal-washing plants. But it is interesting to learn that the froth flotation process—which is of British origin—is increasing in its application in the Ruhr for the treatment of fine coal. We think we are correct in stating that we know of only one colliery in Great Britain where the froth flotation process is in use.

Obituary

JAMES FOSTER-SMITH

WITH deep regret, we have to record the death of Mr. James Foster-Smith, managing director of the Wellman Smith Owen Engineering Corporation, Ltd., which occurred at his home in London on January 24th.

Mr. Foster-Smith was born at Southgate, Middlesex, on July 1, 1880, and, after completing his technical education at Glasgow University, took up appointments first with the Glasgow Crane and Engineering Company and later with Appleby and Co., crane builders. In 1904 he joined the staff of Wellman Seaver and Head, Ltd., as chief engineer, and in that position was actively engaged in the early development of steelworks handling machinery in this country. Mr. Foster-Smith's next appointment was in 1912 as engineer manager of the crane department of Babcock and Wilcox, Ltd., but after a few years he relinquished that position to form the James Smith Hoisting Machinery Company, Ltd. This company joined forces in 1919 with Wellman Seaver and Head Ltd., and as a result of the merger the Wellman Smith Owen Engineering Corporation, Ltd., was founded with Mr. Foster-Smith as managing director. Since then Mr. Foster-Smith's energies have been devoted to the development of the Corporation's business, concentrating particularly on the design and construction of steelworks machinery and metallurgical furnace plant.

Mr. Foster-Smith was a member of the Institution of Mechanical Engineers and of the Iron and Steel Institute. He also served on the Council of the British Engineers' Association, was a Liveryman of the Girdlers' Company and the Founders' Company and a Freeman of the City of London. In addition

to these activities, Mr. Foster-Smith rendered much service to the Order of St. John of Jerusalem, of which he was an officer. During the course of his active life he travelled widely, not only in this country, but in many parts of the world, and friends here and overseas will long remember his characteristic energy and his genial nature.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

INSTITUTION PUBLICATIONS

SIR,—The Institution of Civil Engineers is proposing to launch a new magazine to supplement its existing *Journal* by publishing articles of topical interest in addition to domestic Institution matters.

Hitherto, it will hardly be disputed, the legitimate technical Press has adequately covered topical engineering subjects, and therefore the Institution's proposed competitive venture might not unreasonably be thought an encroachment upon the legitimate activities of private commercial enterprises.

The financing of such commercial enterprises cannot be easy under present conditions, depending, as it does, upon advertisement revenue, and it would be most unfortunate if the Institution, by entering this field without having to meet all the overhead costs which normally have to be faced by commercial firms, were to lay itself open to the charge of unfair competition. There is also the point that such competition by the Institution would, in this hard-hitting world, almost inevitably result in less publicity being given in the technical Press to Institution activities, and so the very object which the proposed new magazine is meant to achieve would tend to be defeated.

I wonder if members of the Institution have thought of all these points, not to mention the questionable professional etiquette involved.

W. A. WILLOX.

Oxted, Surrey, January 28th.

REMUNERATION OF ENGINEERS

SIR,—Many of your correspondents on the subject of remuneration of engineers take the line that the charm and facination of a man's work should be enough compensation; by implication, anyone wanting to better the status of his profession is a mercenary money-grabber.

It would be interesting to have the views of a doctor, lawyer and dentist on this theory. Unless the daily papers are sadly misleading us, these professions have been taking a lively interest in their remuneration and determined action for its improvement. Voices have even spoken (rightly) for the clergy.

Any engineer, however, who expects more than a pittance is, according to your correspondents, a low fellow who should be excluded from the profession.

Is this view general?

F. NEWHOUSE

Twickenham, January 28th.

WHERE DO WE GO FROM HERE?

SIR,—I have read with very great interest the provocative article by Mr. A. K. Rice, which appeared in your issue of December 27th, and also your editorial comment.

The article itself displays a regrettable present-day tendency to exaggerate the disabilities and the repressions of the manual worker. This is carried at times to the point of sickly sentimentality; so much so that the individual is no longer expected, in the scriptural phrase, to work out his own salvation and to look after his own immortal soul. Instead, this is to be done for him by (of all people in the world) his employer. It must be remembered that, after all, the relationship between employer and employee is one of contract, under which the one produces services in a specified capacity for an agreed number of hours at an agreed rate of remuneration. As with every other contract, it is implicit that both parties shall carry it out; from which it follows that the employer would be expected to do everything he possibly can to improve working conditions from his side. The employee similarly would be expected to improve his own abilities and performances, and thereby satisfy the element of mutuality. There is a responsibility on both parties to see that, both in the spirit and the letter, the contract into which they have entered is properly carried out. The fact that the tendency of industry to-day is more and more towards mechanisation, with its inevitable consequence of increased monotony, is beside the point.

Reading and listening, as I have done over a number of years, to the arguments advanced for the improvement of relations between employer and employed in industry, I have often thought that if the manual worker (or any other kind of worker for that matter) regarded himself as being first a human being, secondly a citizen and lastly as the particular kind of worker he happens to be, we might get something better. At present we suffer from conflicting loyalties.

Arising from the same kind of faulty reasoning, which suggests that because a man has a vote in a democratic country he is fit to govern (an obvious fallacy), we get the suggestion that because a man is employed in a particular works he is competent to make practical contributions to its policy and management. For more than three years I have had experience in the chairmanship of a Joint Production Committee; and this, added to similar experience of this kind over a number of years, has satisfied me that we have a very long way to go before such committees can produce any real effect. There is far too much humbug about it all, and a fear of plain speaking, particularly at the present time.

Naturally, these are personal opinions only. Like everyone else in a responsible position in industry to-day, one has to avoid rocking the boat, and only on appropriate occasions dare one say outright what is in one's mind. Looking back over forty years, I am impressed by the contrast between the manual workers' leaders of to-day and those of thirty or forty years ago. Among the manual workers themselves, the kind of man who used to read Ruskin, Carlyle, Herbert Spencer, John Stuart Mill and Black, to say nothing of the classical economists, is conspicuous by his absence.

In any congregation of human beings there will always be leaders and those who are led. All we can do to-day is to facilitate transition from the ranks to the staff, so that the really capable have their opportunity and do not remain at a low level, disappointed and disgruntled, a perpetual source of discontent. But surely our intelligence should be equal to finding some effective means of selection, so that we do not have to train 100 per cent in order to find the 5 per cent or so capable of leadership.

As to putting the whole of the facts relative to a business and its management before the workers, is it seriously suggested that without training they will be capable of understanding, for example, the financial or the export policy of the business in which they are engaged? If, however, we start from the standpoint that obviously they cannot do this, then we may begin their education so that stage by stage some of them may become capable of contributing something in discussion to the practical work of industrial management.

"WHIG."

Sheffield, January 20th.

Gas Turbines for Naval Purposes*

THE possible advantages of the gas turbine for naval propulsion have been realised by the Admiralty for some time, and steps are being taken to develop machinery of this type, both for warships and coastal craft. Gas turbine plant specially developed for naval use is likely to have the following advantages over steam turbine machinery:—

(i) Probable reduction in weight and space for given horsepower, with eventually a gain in overall efficiency, allowing greater radius of action or more weight for weapons or armour.

(ii) Less time required for starting machinery from cold, so that ships in harbour can be ready for sea in a shorter time.

(iii) When satisfactorily developed, gas turbine machinery is likely to be less complicated and less vulnerable than steam machinery.

During the war all the available facilities for research and development were necessarily devoted to the gas turbine for the jet propulsion of aircraft, as this was essential to our defence programme, whereas a gas turbine for warships, although desirable, was not vital. Another factor is that the development period required for marine engines of large horsepower is much greater than is required for aircraft units of lightweight construction and short life. The information gained in the development of jet propulsion engines has been made available by the Ministry of Supply to the Admiralty, which has taken steps to interest firms, other than those engaged in the aircraft industry, in gas turbine work for warships. Some aircraft firms, by agreement with the Ministry of Supply, are forming marine wings.

There are many problems; they include the longer life required for naval machinery, the provision of suitable reversing arrangements, the need to burn heavy fuel oil, and the good cruising economy required. Gas turbine and jet engines developed for aircraft have a life of 300–500 hours, whereas the life required for naval machinery is measured in thousands of hours. The reversing problem has to be solved. Owing to high temperatures involved, the normal astern turbine cannot be used. Variable pitch propellers, electric drive and hydraulic reversing are possible solutions. Gas turbines for aircraft use kerosene fuel, and for the majority of current work this fuel has been used. It may be some time before a satisfactory technique has been developed for burning heavy fuel of the type normally used for ships.

The Admiralty has the following development work in hand at the moment:—

(*a*) Development of gas turbine machinery suitable for an escort vessel.

(*b*) Development of gas turbine machinery suitable for coastal craft in which an aircraft jet propulsion unit is incorporated.

Further high-powered, long-life units are to be developed by well-known aircraft and land firms and by the association of thirty marine firms, known as Parsons and Marine Engineering Turbine Research and Development Association (PAMETRADA). In these developments, close co-operation with the National Gas Turbine Research Establishment has been established. It is emphasised that marine gas turbines present problems which are not encountered in aircraft practice, and that, generally speaking, aircraft units are not suitable and cannot be adapted for marine purposes. Marine designs must therefore be started *ab initio*, and a very great deal of development will be required.

* Admiralty Announcement.

Worshipful Company of Shipwrights' Exhibition

No. I

THE Worshipful Company of Shipwrights' Exhibition, 1947, which was officially opened on Tuesday, January 28th, by the Lord Mayor of London, Sir Bracewell Smith, is designed to reflect the great strides made in recent years in ship construction for the British mercantile marine and the Royal Navy, and to arouse interest in the shipbuilding and marine engineering industries of this country. It is not a trade exhibition in a strict sense, and the proceeds will be devoted to the charitable funds of the Company. It is also hoped that at the conclusion of this exhibition the Company will be able to begin a collection of models and other interesting exhibits, to be ultimately housed in the Shipwrights' Company's Hall, when the time comes for that to be built.

At the close of the Second World War, it is appropriate to view the present and future prospects of the national shipbuiding and ship operating industries. During six long years of war, no less than 1300 liners, 571 cargo ships and half our tanker fleet were destroyed, and only by the middle of last year was it possible to commence the task of reconstruction, some 3,250,000 gross tons of new ships then being on order in British shipyards.

On the stands of this exhibition our seventy shipbuilding firms and many ship-owning firms have brought together what is, without doubt, the largest and most valuable collection of ship models and exhibits, about 2000 in all, ever seen at one exhibition.

The exhibition remains open from twelve noon on Tuesday last till Saturday, February 8th, opening each morning at 10 a.m. and closing at 9.30 p.m., Sundays excepted. It is housed in the two halls of the Royal Horticultural Society, Westminster, the old hall in St. Vincent Square accommodating the Shipowners' Section of 63 stands, while the new hall in Greycoat Street is the Shipbuilders' Section, which has over 163 stands.

It is of interest to recall that the present exhibition is the third arranged by the Shipwrights' Company. The first was held in 1877 in the Fishmongers' Hall, London, and exhibits included models of sailing ships, steamers, fishing smacks, and apparatus used in the operation of ships and also safety equipment. Some 285 models were on view and awards of gold and silver medals were made by the Company. The second exhibition took place in 1882, and was held in the same hall, but it was a larger exhibition. It was opened by H.R.H. Duke of Edinburgh, and some 400 models of ships were shown. Again, gold and silver medals were awarded.

The Worshipful Company of Shipwrights has an authentic history of 700 years, and it is the second largest of the City Guilds in point of membership. King George V is the Permanent Master, and the Court consists of Sir Amos Lowry Ayre (Prime Warden), the Viscount Mountbatten of Burma (Renter Warden), and Major-General Gilbert Savil Szlumper, Sir William Crewford Currie, and Lord Leathers of Purfleet (Wardens). The Exhibition Committee consists of Mr. Walter Pollock (Chairman), Sir Amos Ayre, Mr. George Wigham Richardson, Sir Harold Flannery, Bart., Mr. Alexander Belch, and Mr. Gilbert Findlay (Hon. Clerk); Mr. Kenneth W. Bridges acted as consultant.

Competitions and Awards

In addition to the annual prizes to shipwright apprentices and students, special awards are being made in connection with the present exhibition.

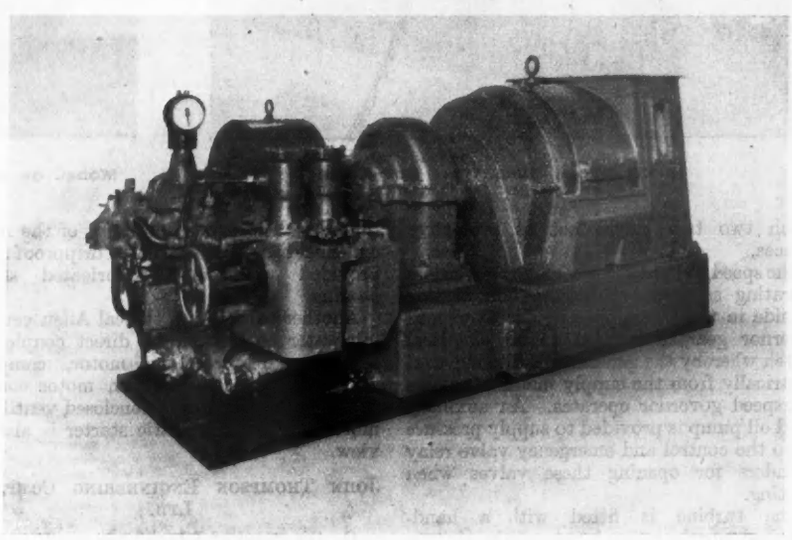
Of special interest is the Ark of Noah Competition, under which the employees of shipbuilding, ship-owning and aircraft construction firms were invited to compete in the construction of a model of the "Ark of Noah." Mr. G. Wigham Richardson, a Past Prime Warden, offered three prizes of £100, £50 and £25 respectively for the first, second and third prizes for competitor or team. There are also consolation prizes. The winning first prize model is to remain the property of the Worshipful Company of Shipwrights. As many as eighteen entries were received for this competition and the prizes were awarded to John Samuel White and Co., Ltd., of Cowes, Isle of Wight, the Fairfield Shipbuilding and Engineering Company, Ltd., of Govan, Glasgow, and the Tyne Dock Engineering Company, Ltd., of South Shields, for the first, second and third prizes respectively. We shall refer further to these interesting models when describing the various firm's exhibits. Other awards include the Ayre Award of a bronze plaque for the best model of a coasting vessel under 1000 tons deadweight; the Billmeir Award for the best model marine engine; the Caledon Award of a bronze plaque for the best series of models by any one firm; the Everard Award of a silver cup or bronze plaque for the most interesting model of a ship not exceeding 200ft in length; and the Pollock Cup in silver for the exhibition's best working model of educational value, either of a ship or marine equipment or both. Three judges have been appointed by the Exhibition Committee.

During the exhibition there are to be forty-five semi-technical papers read and lectures given in the lecture hall, which seats 250 persons. The subjects will cover ships and marine engines, and will deal with careers in shipbuilding, ship-owning, naval architecture and marine engineering. A series of films will also be shown covering a wide range of interesting subjects. Among the objects of the exhibition is that of informing and educating the youth of this country, especially students and apprentices, on all matters connected with the British mercantile marine and with ships and engines. It is the intention of the Exhibition Committee to publish most of the papers in a book of nearly 400 pages, which will be obtainable at 12s. 6d. per copy post free. All students and apprentices who would like to visit the exhibition and are prepared to come in parties, with a senior in charge of each party, are invited to apply for free admission tickets to the exhibition, which include free admission to the lecture hall to see the various films shown and to hear the lectures and papers.

In what follows we propose to deal with some of the more interesting exhibits.

W. H. Allen, Sons and Co., Ltd.

On the stand of W. H. Allen, Sons and Co., Ltd., of Bedford, there is shown a range of auxiliary machinery and equipment for marine use. It includes a turbo-generator, a steam engine driven generating set, a vertical motor-driven pump, a centrifugal pump, a marine motor and starter, and various oil engine exhibits. There are also photographs of metallurgical development work, such as various surface-hardening processes and the testing of welded and electric fusion joints.



80-kW Geared Back-Pressure Turbo-Generator—Allen

The largest exhibit is illustrated herewith. It is an 80-kW geared back-pressure turbo-generator, representative of the firm's range of units constructed to meet all marine auxiliary requirements from 50 kW up to the largest sizes needed in modern service. The turbine is designed to operate with steam at a pressure of 225 lb per square inch gauge at a temperature of 650 deg. Fah. and to exhaust against a back pressure of 20 lb per square inch gauge at sea, and to ship's auxiliary condenser in port. The turbine, which runs at a speed of 10,000 r.p.m., is of the impulse type, consisting of a single, two-row Curtis wheel, and drives the 220-volt d.c. generator at a speed of 1250 r.p.m. through a totally enclosed single-helical reduction gear, lubri-

cated under pressure from the turbine lubrication system.

A horizontal auxiliary spindle driven by a worm and wheel from the turbine shaft carries the speed and emergency governors, and drives a duplex gear oil pump. The turbine embodies two oil systems, one using high-pressure oil at about 60 lb per square inch and the other using low-pressure oil at about 15 lb per square inch.

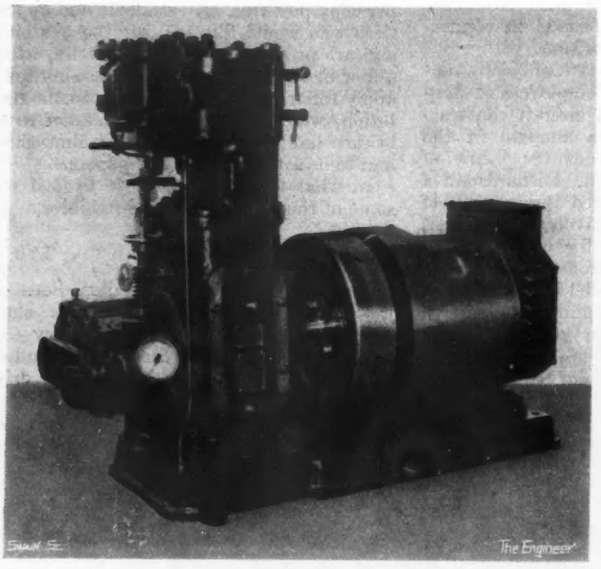
The turbine throttle valve is operated through a "leverless" oil relay, which is under the control of the speed governor, in which two trip valves act as protective devices.

The speed control and emergency governors operating separate valves are housed side by side in the steam chest. The overspeed governor gear is coupled to an electrical switch whereby the generator is disconnected electrically from the supply mains when the overspeed governor operates. An auxiliary hand oil pump is provided to supply pressure oil to the control and emergency valve relay cylinders for opening these valves when starting.

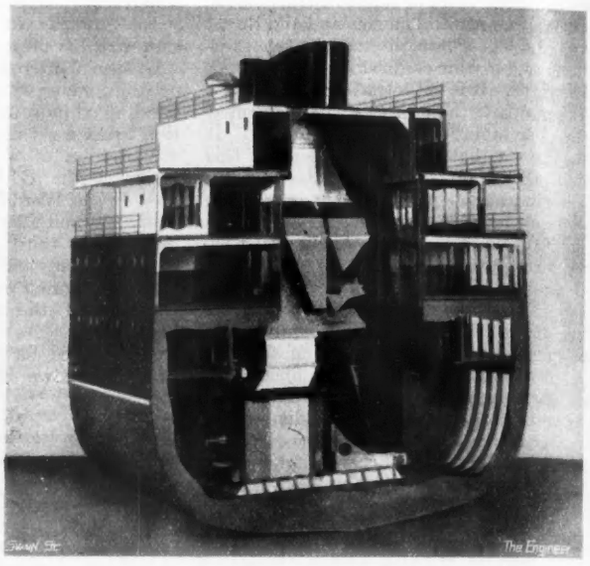
The turbine is fitted with a hand-operated nozzle control valve, whereby an additional group of nozzles is brought into action, so as to obtain full output under reduced steam pressure conditions or 10 per cent overload with normal steam pressure. The generator is of the d.c. compound-wound enclosed type, arranged for closed circuit air cooling in conjunction with an air cooler situated below the generator. The machine is rigidly coupled to the slow-speed shaft of the speed reduction gear.

The other steam exhibit we illustrate is a single-cylinder, enclosed engine direct coupled to a 10-kW d.c. generator, typical of the Allen range of units from 5 kW to 50 kW for ships' auxiliary power and lighting services. The engine is designed for operating with steam at a pressure of 120 lb per square inch gauge, and drives the 110-volt generator at a speed of 550 r.p.m. The engine is pressure lubricated, a valveless pump of simple design being used to supply oil to all the bearings through a suitably arranged service main. On the suction side of the pump a strainer is fitted, ensuring that only clean oil enters the bearings, whilst an adjustable by-pass and relief valve is fitted to regulate the oil pressure. The working parts are enclosed in a cast iron trunk with a door arranged to give easy access to the interior. A centrifugal governor, supplied with oil from the lubrication system, is mounted on the end of the crankshaft and directly connected to the throttle valve. It controls the speed of the engine between full load and no load, so that normally the permanent rise or fall is not in excess of 3 per cent. Hand-regulating gear is also fitted to enable the speed of the engine to be varied if necessary whilst the engine is running. The d.c. generator is of the Allen end-shield enclosed ventilated dripproof type, provided with a ring-lubricated sleeve bearing.

Another exhibit is a typical Allen vertical salt-water cooling pump, direct coupled to a 2½ h.p. dripproof d.c. motor, complete with a hand-operated drum motor control panel. A 2½ h.p. marine enclosed ventilated motor with an automatic starter is also on view.



10-KW STEAM GENERATING SET—ALLEN



MODEL OF JOHN THOMPSON LA MONT MARINE BOILER

JOHN THOMPSON ENGINEERING COMPANY, LTD.

On the stand of John Thompson Engineering Company, Ltd., of Wolverhampton, and its subsidiary firms there is to be seen an interesting model of the John Thompson "La Mont" marine boiler, installed in a cargo ship now under construction at Swan, Hunter and Wigham Richardson's yard, for the Compagnie de Navigation Mixte. The boiler installation has a designed evaporation of 80,000 lb per hour, and a working pressure of 500 lb per square inch, with a final steam temperature of 752 deg. Fah. The La Mont boiler works on the forced circulation principle. Water is drawn from the steam drum by the circulating pump, which discharges it into a main distributor header furnished with nozzles and strainers so that no foreign matter enters the boiler. From the header the water passes into the different tube circuits, the combustion chamber tubes, the first evaporating section and a second evaporating section. It then returns to the steam drum, having completed one circuit. The process of circulation is repeated approximately thirty times an hour. The makers of the boiler claim that much greater evaporation is achieved in a smaller space than in a boiler of the natural circulation type. There is also a saving in weight; with a La Mont boiler of the above output the weight, it is claimed, would be about 100 tons, compared with 600 to 700 tons for a natural circulation boiler of the same capacity. No heavy brickwork is needed and as the combustion chambers are water cooled the thickness of brickwork and insulation can be cut down. Easy steaming is claimed and the boiler can be brought from cold to maximum steaming conditions in about one hour, and from standby conditions up to full load conditions in about twenty minutes. All parts of the boiler are designed to be replaceable, and only a minimum of spare parts is called for.

(To be continued)

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The prices of each specification is 2s. 3d. post free, unless otherwise stated.

PAPERS (TRACING, DETAIL AND CARTRIDGE)

No. 1340–43 : 1946. Four more British Standards in the drawing-office equipment and material series have been issued in a single booklet, the titles of the specifications being: prepared tracing paper, natural tracing paper, detail drawing paper and cartridge drawing paper. The various papers are described and the sizes of rolls and the substances and surfaces of the papers are specified in each case. Other clauses in the specifications relate to the formation of the papers and to the make-up and labelling of the rolls. The standard sizes of cut sheets of tracing and drawing papers are given in an appendix. The price of the booklet is 2s. post free.

RECOMMENDATIONS FOR PHOSPHATE COATINGS AS A BASIS FOR PAINTING STEEL

P.D. 539 : 1946. These recommendations have just been issued by the British Standards Institution as an interim measure for the assistance of industry. Instructions are given on the method of application of satisfactory coatings and elementary tests of the suitability of the coating are described. Research is now in progress, and it is intended to prescribe performance tests as soon as sufficient data is available. Price 1s. post free.

Hydro-Electric Power Installations in France

IN spite of the frustrations brought about by the enemy occupation of France in 1940–44, some progress was made during the war years with the construction of dams and other works for the generation of hydro-electric power, which had been begun before the invasion in 1940. Since the surrender of Germany in 1944 the completion of works, which had been closed down throughout the war and of others whose progress had been severely restricted, has been actively proceeded with. During the ten years, 1936–45 inclusive, no less than thirty-six installations, having installed capacities of 2500 kW and upwards, were brought into operation or were at the end of 1945 nearing completion. Among those not yet in operation are the great dam and power plant in the Rhone Valley at Génissiat, of 260,000 kW, and a potential annual output of 1580 million kWh; L'Aigle, 200,000 kW and 490 million kWh; and Cordeac, 60,000 kW, which with its associated plant at Le Sautet, completed in 1935, will have a combined annual output of 426 million kWh. We have already published in this journal illustrated descriptions of the works at Génissiat (December 30th, 1938, and November 24th, 1939) and L'Aigle (June 21st and 28th, 1946).

Among the hydro-electric power stations of large capacity brought into operation in France in the years immediately preceding 1936 are :—

Name.	Completed.	Installed capacity, kW.	Annual output of power millions of kWh.
Brommat	1932	167,000	970 (with Sarrans)
Kembs	1932	150,000	816
Sarrans	1934	102,000	230
Marèges	1935	140,000	345
Le Sautet	1935	74,300	215
Bissorte	1935	70,000	152 (with Crescent)

At the end of 1945 there were in operation or nearing completion in France 293 hydro-electric power installations of 2500 kW capacity and upwards, in addition to upwards of 440 installations of less than 2500 kW installed capacity.

Towards the end of 1945 the Chambre Syndicale des Forces Hydrauliques in collaboration with the Société Hydrotechnique de France issued an Atlas Hydroélectrique of technical data and descriptions of all hydro-electric power installations in France, large and small. The volume is well illustrated and contains plans and photographs of many of the larger installations. We are indebted to this publication and to the President of the Chambre Syndicale, Monsieur Jean Dupin, for the data which we have summarised in the table below, relating to installations of 2500 kVA and upwards put into operation or under construction from 1936 to 1945 inclusive. The interest and activity displayed in France in the further utilisation of hydro-electric power may be gauged by the fact that in June, 1945, more than 120 applications for concessions relative to proposed installations were under consideration in the several departments of the State concerned. These proposals represent a poten-

Hydro-Electric Power Installations in France

Name of H.E. power installation.	Year when installation was put into operation.	River.	Department.	Installed power capacity, kW.	Head of water with reservoir full, m.	Usable water storage million cubic metres	Max. height of dam above (*a*) foundation or (*b*) river bed (thalweg), m.	Crest length of dam, m.	Type of dam.	Mean annual output of power, million kWh.	Power units (*a*) intended, (*b*) actually installed, kVA.	Type of turbine.
1	2	3	4	5	6	7	8	9	10	11	12	13
Lac Noir[1]	1938	—	Haut-Rhin	100,000	128	2	—	—	—	100	(*b*) 4×25,000	F
Rophemel	1937	Rance	Côtes du Nord	5,000	22	2·4	(*b*) 25	126	MA	3·4	(*b*) 2×3,125	K
Vendets	1942	Lignon du Velay	Haute-Loire	8,510	—	Nil	(*b*) 5	61·5	W	37	(*b*) 1×9,000	—
L'Allier (Poutes)	1941	L'Allier	Haute-Loire	15,000	61·5	2·2	(*b*) 16	70	G	55	(*b*) 1×9,000	F
L'Aigle[2]	Build., 1945	Dordogne	Cantal	200,000	80	160	(*b*) 90	275	G-A	400	(*a*) 4×60,000 (*b*) 2×60,000	—
Neuvic D'Ussel[3]	Build., 1945	Triouzoune	Corrèze	19,700	240	22·8	(*b*) 27	145	A	56	(*a*) 2×12,500	F
St. Etienne-Cantales[4]	1943	La Cère	Cantal	75,000	62	100	(*a*) 70	270	G-A	250	(*a*) 3×30,000 (*b*) 1×30,000	F
Monceaux-La Virole	Build., 1945	Vézère	Corrèze	13,250	134	17·6	(*a*) 29	105	A	64	(*a*) 2×19,000	F
Eylie[5]	1936	Lez	Ariège	28,000	993	8·3	(*b*) 25	251	E	35·2	(*b*) 3×11,400	P_h
Le Teich	1941	Origège	Ariège	4,800	89	—	(*b*) 9	42	G	27	(*a*) 1×6,250	F
Orgeix	Build., 1945	Lauze	Ariège	5,200	232	—	(*b*) 18	70	G-A	19	(*b*) 2×3,150	P_h
La Barre	Build., 1945	Ariège	Ariège	4,400	11·5	0·5	(*b*) 15·5	70	A	18·6	(*a*) 1×5,000	K
Pradières[6]	1939 and 1940	Gnioure, Siguer, and Artiès	Ariège	30,000	604 449	38·5	(*b*) 72 Gnioure (*b*) 162 Izourt	260 162	G G	68	(*b*) 1×12,500	P_h
Portillon[7]	1941	Neste d'One	Haute-Garonne	40,000	1,336	12·6	—	—	—	35·3	(*b*) 1×50,000	P_h
Lac Bleu	1942	La Pique	Haute-Garonne	40,000	1,065	1	—	—	—	49·0		
Maison Blanche	Build., 1945	Rioumjou and Bidourte	Haute-Pyrénnées	7,300	284	—	(*b*) 26	55	G-A	31·5	(*a*) 1×10,000	P_v
Guchen	1943	Lavedan	Haute-Pyrénnées	5,000	470	—	(*b*) 4·25 ht. of gate	—	W	22·6	(*b*) 1×2,500 1×4,200	P_h
Vintrou (St. Peyres)[8]	1936	l'Arn	Tarn	34,700	247	32	(*b*) 60	180	G	152	(*b*) 1×14,750	F_h
Baous (Sirous)[9]	Build., 1945	l'Arn	Tarn	11,000	120	0·3	(*b*) 22	52	A		(*a*) 1×7,150	F_h
Fumel	1944	Lot	Lot-et-Garonne	5,600	7·2	1	(*b*) 10	70	G	36·4	(*b*) 2×4,000	K
Artigues[10]	1943	Adour de Garet	Hautes-Pyrénnées	18,000	790	2·6	—	—	—	26	(*b*) 3×10,000	P_h
Fabrèges	Build., 1945	Gave de Brousset	Basses-Pyrénnées	8,500	105	6·7	(*b*) 51	165	A	24	(*a*) 1×9,500	F
Saint-Cricq[11]	Build., 1945	Gave d'Ossau	Basses-Pyrénnées	9,600	64	—	6 ht. of gates	About 20	—	53	(*a*) 2×6,000	—
Pont de la Reine[12]	Build., 1945	Gaves de Gavarnie et du Bastan	Haute-Pyrénnées	13,500	70	—	—	—	—	55·5	—	K
Baigts	1943	Gave de Pau	Basses-Pyrénnées	6,500	9·2	—	5·5 ht. of gates	40	W	37·8	(*b*) 3×2,780	—
La Bouillouse[13]	Fontpedrouse 1943 Lacassagne 1944 Thues build., 1945	La Têt	Pyrénnées Orientales	23,000	166 410 158	20	(*b*) 17·5	354	G	15·8 34 26·8	1×6,000 2×6,000 2×4,000	P_h P_v F
Usson	1943	Tributaries of l'Aude	Aude	8,800	236	100	(*b*) 14	80	EGA	30	(*b*) 1×11,750	P_h
Vaufrey	Build., 1945	Doubs	Doubs	6,500	11·2	2	(*b*) 14	45	G	21·6	(*a*) 2×4,000	K
Dampjoux	Build., 1945	Doubs	Doubs	3,600	7	0·6	7 ht. of gates	50	W	16·3	(*a*) 2×2,250	K
Génissiat	Build., 1945	Rhône	Ain-Haute Savoie	260,000	64·5	12	(*a*) 105·5	200	G	1,580	(*a*) 4×70,000	F
Fontanus	1940	Doron	Savoie	14,600	396·4	0·25	(*b*) 16	300	—	63·5	(*b*) 2×7,500	P_h
St.-Michel-de-Maurienne[14]	1942	l'Arc	Savoie	10,000	47	—	—	—	—	56	(*b*) 2×5,650	F
Cordeac[15]	Build., 1945	Drac	Isére	60,000	83·7	—	(*a*) 40	16	G	426[18]	(*b*) 1×40,000 1×20,000	F
Champ-sur-Drac[16]	1941	Drac	Isère	6,800	28·1	—	(*b*) 2	146	W	41·4	(*b*) 1×6,500	F_h
Chambon[17]	1937	Romanche	Isère	5,500	61	49·5	—	—	—	135	(*b*) 2×3,500	F_h
Pont-Escoffier	1944	Vénéon	Isère	50,000	378	15·5	(*b*) 3 ht. of gates	52	W	240	(*b*) 4×13,000	P_h
Castillon	1945	Verdon	Basses-Alpes	48,000	88·6	122	(*b*) 95	170	A	78	(*b*) 4×17,000	F

Column 10.—M-A, multiple-arch; W, weir; G, gravity; A, Arch; E, Rock-filled embankment.
Column 13.—F, Francis; F_h, horizontal Francis; K, Kaplan; P_h, horizontal Pelton; P_v, vertical Pelton.

[1] Pumped storage. Maximum pumping head from Lac Noir to Lac Blanc, 128 m. Surplus electric power from Kembs barrage is utilised for pumping.

[2] *Vide* THE ENGINEER, June 21st and 28th, 1946.

[3] The power station is on the right bank of the Dordogne, of which the Triouzoune is a tributary.

[4] *Vide* THE ENGINEER, August 24th, 1945.

[5] The barrage holds up the waters of the Lac D'Araing.

[6] The two dams store water for the power station of Pradières.

[7] Water is drawn from Lac Glacé and Lac Portillon through pressure tunnels. The head of water (Portillon, 1400 m) is the highest operated in France. The pressure pipe line from Lac Bleu supplements the supply to the power station at Portillon.

[8] Tunnel 3 km long, 8·5 square metres section.

[9] Tunnel 2·5 km long, 5·25 square metres section.

[10] The power station is supplied by water from lakes Campana and de Greziolles through tunnels.

[11] Tunnel 2·7 km long by 10 square metres section.

[12] Tunnel 352 m long.

[13] These power stations supplied from reservoir at La Bouillouse.

[14] The water supply is taken from the turbine discharge of the power station at la Saussaz.

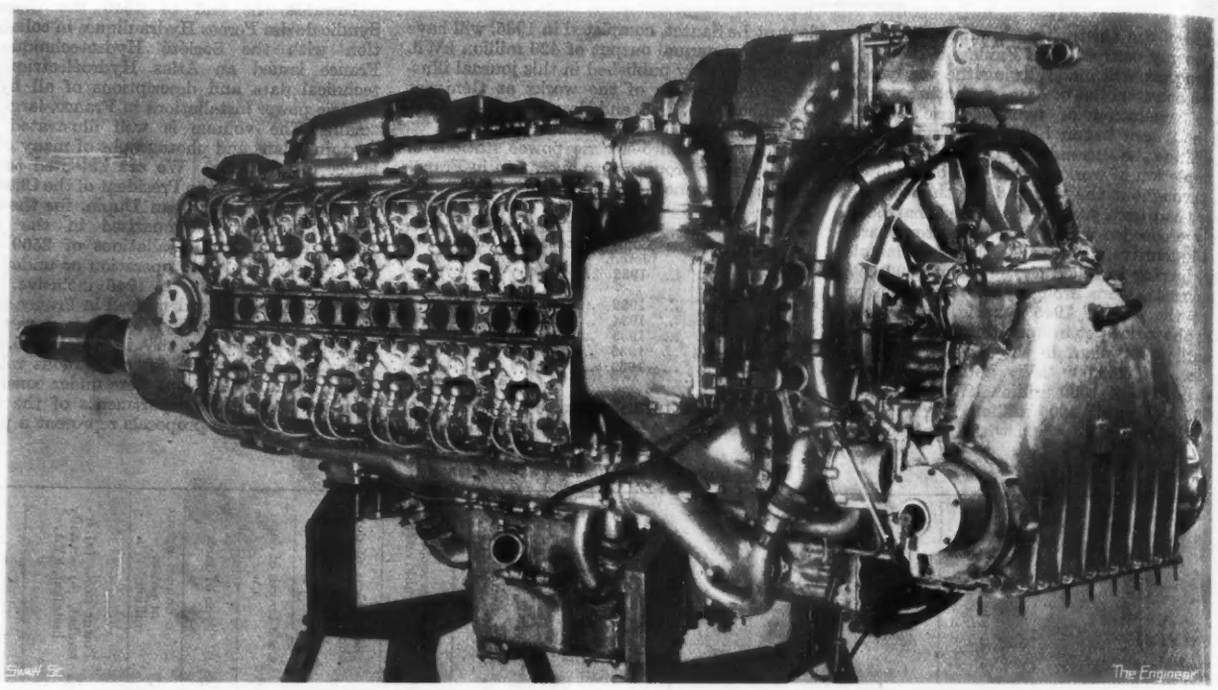
[15] The water supply is derived from the turbine discharge at the Sautet dam (1935) higher up the Drac.

[16] Tunnel 4616 m long by 3·3 m diameter.

[17] The power station is close to the downstream face of the Chambon gravity dam (136·7 m max. height above foundations, completed in 1934). The dam has a crest length of 294 m.

[18] Combined output of Sautets and Cordeac.

3500 H.P. "EAGLE" AERO-ENGINE



tial annual output of some 30,000 million kilowatt-hours.

Some large dams have been designed in France in recent years in which provision is made for the discharge of flood waters by a spillway which also serves as the roof of the power station on the downstream face of the dam. Outstanding examples of this design are L'Aigle, almost completed, and Saint-Etienne-Cantales, completed in 1943.

The Marèges dam, completed in 1935, is a single horizontal arch, 90 m in height above the foundations, with a length on crest of 247 m. The design is of special interest, owing to the slender proportions of the arch, which near the base has a maximum thickness of no more than 19 m. It is probably the largest pure arch dam in Europe. The head of water available at the turbines, situated near the downstream face of the dam, with full reservoir, is 70·5m. The available water storage is 34 million cubic metres.

Le Sautet arch dam is noteworthy for the exceptionally narrow rock gorge in which it is built and for its height, 126 m above the river bed. The crest length of the arch is no more than 80 m, and for more than half the height of the dam the face width of the structure is less than 30 m. The power installation, operating under a head of 91 m with full reservoir, is in the narrow gorge downstream of the dam.

CHINA'S NEW AIRLINES.—Plans for starting up four international airlines under the operation of the China National Aviation Corporation and the Central Air Transport Corporation have been mapped out by the Ministry of Communications. The four lines, it is reported, will be called China-America, China-Europe, China-Philippines and China-Siam. The China-America service will operate between Shanghai and New York, with stops at Guam, Wake Island, Honolulu, San Francisco and Washington; the China-Europe line will link Shanghai, Canton, Hong Kong, Hanoi, Bangkok, Calcutta, New Delhi, Teheran, Ankara, Athens, Rome, Marseilles and Paris; and the China-Philippines and China-Siam lines will have Shanghai as its northern terminus and Manila and Bangkok, respectively, for its southern terminus. It is learnt that the Central Air Transport Corporation will also establish three domestic services to link Shanghai with Harbin in the north-east, with Hoihow on Hainan Island in the south and with Ining, of Sinkiang Province, in the north-west.

Rolls-Royce "Eagle" Piston Aero-Engine

PRELIMINARY information and the photograph reproduced above are now released in connection with the new Rolls-Royce "Eagle" piston-type aero-engine, which is nominally rated at 3500 h.p. This powerful new engine—the most powerful piston engine at present in use in Great Britain—is, of course, named after the first famous "Eagle" engine produced thirty years ago through the genius of Sir Henry Royce, which set a high standard of performance and reliability, and was in its day the most powerful British engine in production.

As yet little information is permitted to be published; but, as is indicated in the illustration, the engine is an "H" type, with four rows of six cylinders in line. It is liquid cooled and has sleeve valves, the overhead valve gear being noticeably absent. As is perhaps to be expected, the "Eagle" in its initial version is fitted with a two-speed, two-stage supercharger and contra-rotating propeller reduction gear, since both these components have been developed successfully by Rolls-Royce, Ltd., for the "Merlin" and "Griffon" engines. After-coolers are placed between the supercharger outlets and the induction manifolds of each cylinder block, for cooling of the charge after compression. The "shunt" cooling system, with header tank integral with the forward end of the top of the crankcase, is used. In common with the later "Merlins" and "Griffons," the "Eagle" has fuel injection discharging into the air stream at the supercharger eye. For this system Rolls-Royce, Ltd., has developed a fuel injection pump, which is mounted on the lower half of the crankcase. Dual ignition is provided by two B.T.H. waterproofed magnetos, one on each side of the reduction gear casing. In designing the housing of the reduction gear care was taken in respect of securing minimum power plant drag, in conjunction with Rotol contra-rotating eight-bladed propellers.

Rolls-Royce, Ltd., has always pursued an active development programme for internal combustion engines, and for many years the possibilities of air cooling, sleeve valves, two-cycle and compression-ignition engines, and direct fuel injection have been studied, with engines built and run at Derby. War, however, demanded concentration in other directions, but when more work of this type was possible, after the end of hostilities, development of the "Eagle" went forward apace, with the result that the engine has now undergone its first flight trials in a high-performance aircraft, built by Westland Aircraft, Ltd.

The high power output of the engine in its initial form may be taken to indicate that further development will take place. It will therefore have many uses in the field for which the high-power piston engine is still suitable, notwithstanding the parallel developments taking place with gas turbine engines.

Remote Controlled Arc Welding Current Regulator

IN welded ship construction, and in other classes of site welding work, it frequently happens that the operator requires to control the arc welding current at a point remote from the regulator. To meet these requirements, the Quasi-Arc Company, Ltd., Bilston, Staffs., has developed the R.M.R. 300 regulator, which provides remote control of a 100 volt multi-operator a.c. arc welding equipment.

The regulator consists, essentially, of a moving core, which is operated by an a.c. motor, supplied from the secondary side of the welding transformer and controlled by a push button switch. A length of light three-cored cable connects the regulator to the push button switch, which can be carried by the welder. The switch incorporates two push buttons for lowering and raising the current. No further auxiliary equipment is required, and the switch gives the operator complete control of his welding current, which can be adjusted without delay to suit the class of work and the size of electrode.

The rated output of 18 kVA is obtained when the regulator is connected to a transformer having a secondary voltage of 100, but transformers of lower voltage can be used with a corresponding decrease in output. A time interval of 20 seconds is required for the regulator to cover the current range of 75 amperes to 300 amperes. The regulator is oil-cooled, and weighs 645 lb in its sheet steel tank, which measures 21½in by 31in by 37in high.

Europe's Need of Scientific Instruments

In the early part of last year a joint Anglo-American Mission visited various countries in Europe in order to assess the existing needs for scientific instruments and laboratory equipment. The first suggestion of such a mission of inquiry was made at the meetings in London of the Science Commission of the Conference of Allied Ministers of Education. In the course of discussions on the rehabilitation of universities, research laboratories and schools in the devastated countries in particular, and following the preparation of standard lists of apparatus, it was concluded that Britain and the U.S.A. must, under immediate post-war conditions, be the principal suppliers of the equipment needed.

The result of these discussions was that the Ministry of Supply in London and the State Department in Washington were asked to nominate suitable technical officers to undertake the mission which visited France, Switzerland, Italy, Greece, Austria, Czechoslovakia, Belgium, Holland, Denmark, Norway, Poland and Sweden. It was agreed that the two sections of the mission should report separately to their Governments, and there has just been issued the report made by Mr. Thomas Martin and Mr. R. W. H. Cook, of the Ministry of Supply, who formed the British section of the mission.

The report explains that the mission had two general objects in view: first, that of ascertaining as closely as possible the extent of the war losses of scientific instruments and laboratory equipment; and, secondly, of collecting as much information as possible regarding the nature and extent of the rehabilitation requirements to enable the instrument industries to plan for meeting the demands which might be made on them. As a result of its inquiries the mission found that the extent of the losses as a whole had been exaggerated. In Poland, Greece and Italy it was found that the losses of scientific equipment were severe, but elsewhere, while the losses were serious enough, they were often more localised and the problem of replacement thus becomes more manageable. The British members of the mission quote figures "with the utmost diffidence," but they estimate that the total cost of replacement of the losses of scientific instruments and laboratory equipment sustained by the European countries will be not more than £18,000,000 and not less than £14,000,000. Some countries, it is pointed out, have considerable instrument making resources of their own, and in others uncertainty as to relief grants and shortage of foreign exchange is likely to limit overseas buying for some time. Taking these circumstances into account, it is probable that the immediate call on instrument production in Britain and the U.S.A. is not likely to exceed £5,000,000. These figures, of course, relate only to the countries which the mission visited, and they do not take into account the important requirements of Switzerland and Sweden.

The report goes on to say that although the immediate call on Anglo-American production may be somewhat smaller than was at first anticipated, it should not be concluded that the commercial possibilities are unimportant or that future demands may not be considerable. The mission found, in many countries, intense interest in Anglo-American technical progress during the war, and a determination to fill the gap in scientific knowledge caused by the cutting off of communication with Britain and the U.S.A. during the German occupation. It is suggested, therefore, that Great Britain has a heavy responsibility and a remarkable opportunity in regard to the educational rehabilitation of Europe, but it must also be recognised that in many countries little is known of the resources of British instrument making. One step towards correcting this state of affairs is, the mission asserts, the setting up of effective agencies for the British scientific instrument industry in the European capitals, and it is essential that these agencies should be provided, not only with literature, but with instruments in sufficient quantity to allow them to be lent and demonstrated and not merely looked at. Moreover, servicing facilities should also be provided.

The mission says with certainty that there is no type of scientific equipment which is not wanted somewhere in Europe, and for that reason it was not found practicable to bring back anything in the nature of detailed lists with quantities attached for each country. It is felt also that interest in wartime technical developments, particularly radar and atomic physics, will cause a demand for new equipment in many places.

The report includes a survey of the scientific instrument position in each of the countries visited, and adds, generally, that greatly accelerated production of scientific instruments and laboratory equipment are needed to relieve the existing European shortages. It is disturbing, therefore, the mission comments, to come back to England after months of absence and find the British instrument industry still struggling with the problems of shortage of skilled labour and inadequate factory accommodation. Production is needed urgently from every point of view, and on commercial grounds it is needed if the industry is to realise the export possibilities which the European situation presents. The extent to which Britain may be able to take the place of Germany in the European export market for scientific instruments depends on the amount of the deliveries she is able to make over the next two or three years. In such circumstances, the report says that it is reasonable to ask that special consideration should be given to the post-war problems of the scientific instrument industry.

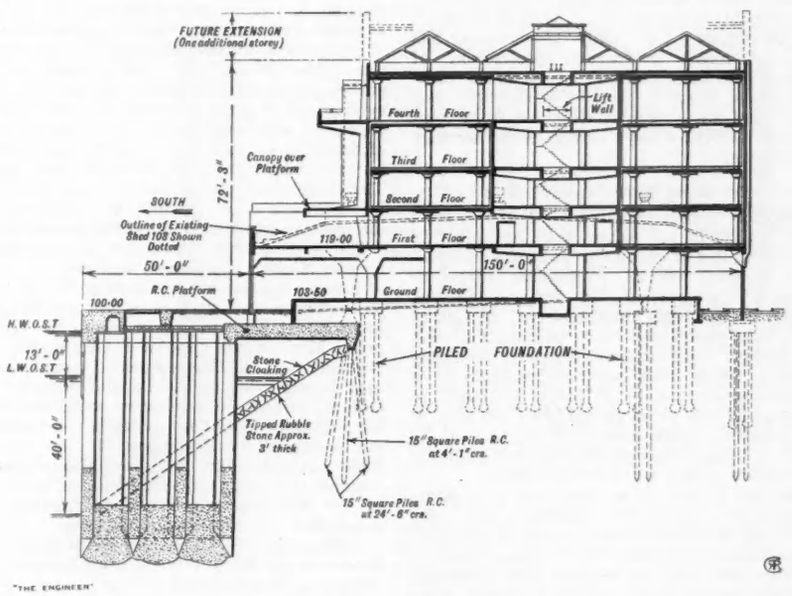
London Transport Improvements

In the course of an address given at Tottenham, on Monday, January 20th, to the Rotary Club, Mr. J. H. Brebner, chief public relations and publicity officer of London Transport, made mention of several forthcoming improvements to London's transport system. Five hundred new type buses, he said, would soon be received and put into service. They would be of a type far in advance of any bus used in this country or in any part of the world. Negotiations were now being conducted with the Metropolitan Traffic Commissioner regarding the extent to which the new 8ft wide buses could be introduced into the Central London area, as well as the outer areas of London. The Central line from Liverpool Street to Stratford would again be extended in 1947. New tracks were in course of construction alongside the Great Western line from North Acton to Greenford, and new stations would be built at Hangar Lane and Perivale. Wood Lane Station was being reconstructed to accommodate eight-car trains, and the whole of the western section would be relaid with new 300ft long rails. Track improvements between Wembley Park and Harrow-on-the-Hill on the Metropolitan line would be completed in 1947. A new cross passage is to be made at Leicester Square, giving improved interchange between the Piccadilly and Northern lines. During 1947 push-button door control will be introduced on the Central line. Approximately 230 new cars are on order to supplement the present rolling stock on the London Transport railway system. The bus and coach overhauling works at Chiswick are to be reorganised. The increases in passenger traffic and mileage run were noteworthy. The 1946 figure of 579 million miles represented an increase of 100 million miles over the 479 million miles run in 1945 and the mileage of London Transport's road vehicles showed an increase of 28 per cent over the 1945 figure. The number of passengers carried by those road vehicles was 4400 million, which compared with the previous record of 3882 millions carried in 1938–1939.

Cold Store for Southampton Docks

The Southern Railway Company has announced plans for a new and improved cold store at Southampton docks to replace the original cold store which was almost entirely destroyed by bombing in 1940. The new cold store is to be erected at the western end of Berth 108 in the new docks, a site which the Southern Railway claims will offer better road, rail and sea facilities than the former one at Berth 40, and will permit a speedier movement of cargo in and out of the store.

Preliminary work on the site has already been started, and the new store—a section through which is reproduced on this page—is to be constructed in reinforced concrete with five storeys giving space for 6000 tons of meat, fruit and dairy produce. Up-to-date refrigerating plant will be installed. The total cost of the new store is estimated at £250,000, and the work of construction is to be carried out under the direction of Mr. M. G. J. McHaffie, the Southern Railway Company's docks engineer. Messrs. Scott and Wilson have been engaged as consultants for the fabric of the building and Mr.



SECTION THROUGH COLD STORE

Oswald Parratt has been appointed quantity surveyor.

It is understood that the Ministry of Works has agreed to issue licences for each stage of the work, and the project has the full support of the Ministry of Food. When completed, the building will be leased by the Southern Railway to the International Cold Storage and Ice Company, the lessees of the old store.

Fluorine*

THE new techniques developed and used, especially in the work on the atomic bomb, for making both fluorine gas and its compounds on a large scale, have opened a new era of chemistry for development. Hydrogen fluoride as a catalyst in gasoline production, uranium hexafluoride as an intermediate in the atomic energy programme, the "Freon" products used as refrigerants and in insecticide bombs, and a new fluorine-containing plastic have all become important applications and have increased the interest in the unusual chemical possibilities of fluorine compounds. A symposium reporting late developments to a recent meeting of the American Chemical Society was introduced with the statement that the next few years would see many new products containing or using fluorine. Eventually fluorine may even approach in importance its chemical relatives, chlorine and bromine. Production of the former in the United States is valued at 40 million dollars, and of the latter at 20 million dollars a year.

Fluorine chemicals are derived ultimately from fluorspar, a common mineral produced in the United States chiefly in Illinois and Kentucky. Fluorine itself is prepared by electrolysis of a solution of hydrogen fluoride in molten potassium fluoride. One widely used cell operates at about 212 deg. Fah. During the war, fluorine gas was produced on a scale of tons per day from full-sized units. Although the only price mentioned for it thus far is 20 dollars a pound for experimental quantities, the price for commercial quantities will be much lower, but probably never as low as that of chlorine, now 35 dollars a ton. Only one company has yet announced commercial production of fluorine; a large number of chemical companies has, however, worked in the field, but these were until recently debarred from commercial activities by Government security regulations.

FLUORINE NOW MANAGEABLE

Fluorine, a pale yellow gas, is sold in steel tanks at 400 lb per square inch pressure. It can be handled at normal or moderate temperatures in steel, copper, magnesium, nickel or "Monel" apparatus. A fluorine plastic, "Teflon," has been found resistant enough to serve as a gasket and valve packing material. At higher temperatures fluorine is highly reactive, for it is the most electronegative of all elements—that is it reacts similarly to oxygen but much more readily. Because of this property, sand, glass, and the like can be made to burn in fluorine, and red-hot steel and most other metals will burn brilliantly.

Because fluorine is so reactive, many of its compounds, organic or inorganic, are very stable, an important characteristic industrially. Replacement of hydrogen in an organic chemical by sufficient fluorine usually will materially enhance the chemical's stability toward heat, oxygen and other deteriorating influences. Organic materials containing fluorine which are now commercially available, notably the "Freon" series of solvents and refrigerants, have generally been produced from the corresponding chlorine-containing chemical by replacing part or all of the chlorine with fluorine from a compound such as hydrogen fluoride. Availability of elemental fluorine may permit production of many compounds not possible through this replacement reaction.

A large number of organic fluorine compounds were prepared during the war by the use of both elemental fluorine and hydrogen fluoride, but their properties have not been reported in detail, and the commercial development of many of these compounds apparently has not yet proceeded far. Liquids formed by fluorination of hydrocarbons, as from petroleum, may be made to have high density, high boiling point, non-toxicity and non-flammability. At least one of these oils was made in large quantities for wartime purposes. One possible application of them would be as heat-transfer fluids for high-temperature use. Modification of such materials could provide highly stable lubricating oils. Further research may also lead to more fluorinated resins, such as the recently introduced "Teflon," which is said to have remarkable resistance to practically all solvents and corrosive agents and to retain its strength and form at higher temperatures than any other known organic material.

* From *Industrial Bulletin* of Arthur D. Little.

The Industrial Organisation Bill

THE Industrial Organisation Bill was introduced in the House of Commons on Friday last by Sir Stafford Cripps, President of the Board of Trade. Its purpose is to enable the Board of Trade, the Minister of Agriculture, the Minister of Supply, the Minister of Food, the Minister of Works, the Admiralty, the Secretary of State or the Minister of Fuel and Power, after consultation with organisations of workers and employers in an industry, to establish for that industry a central body to be known as a Development Council.

The general objects of such Councils will be to increase the efficiency and productivity of their industries and to enable them to render better and more economical service to the community. An Order setting up a Development Council, which must be approved in draft by both Houses of Parliament before it is made, may confer on the Council various functions listed in a Schedule to the Bill. These functions include promoting or undertaking scientific research and promoting or undertaking inquiry as to materials and equipment and as to methods of production, management and labour utilisation. The Development Council may also be authorised to collect statistical information of a type and in a form approved by the Minister concerned and to collect a levy for the purpose of financing its activities, at a rate not exceeding the maximum laid down in the Order. There are rigid restrictions on the disclosure by members of a Council or its officials of information relating to individual businesses.

The Development Councils are to be appointed by the Minister concerned, and are to consist of persons capable of representing the interests of employers and workers in the industry and independent persons, one of whom the appropriate Minister will appoint as Chairman. The provisions of a Development Council Order may be amended or the Council dissolved by Orders, subject to the same conditions concerning prior consultation with the industry and approval by Parliament as the original Order. An amending Order may also assign to a Council, at its own request, functions not listed in the Bill, but which can conveniently be associated with its existing functions.

A clause in the Bill enables the Minister concerned to collect a levy from an industry for which no Development Council exists, if he considers it necessary that finance should be made available for the promotion of scientific research, the development of exports, or the improvement of design in that industry. Orders made under this clause are subject to the same requirements relating to prior consultation with the industry and approval by Parliament as Development Council Orders. The money thus collected will be paid into a public fund or account, and will be issued from it to the appropriate industrial bodies. Accounts giving details of the collection and disposal of sums under arrangements of this kind must be laid annually before Parliament.

Certain balances which accumulated from levies imposed during the war on various industries under the Defence (Encouragement of Exports) Regulations, 1940, have been paid into the Exchequer. Another clause in the Bill authorises the payment of equivalent sums to bodies connected with the industry in question for purposes approved by the authority making the payment. This expenditure will be borne by the Board of Trade. The Bill authorises the Board of Trade, with the approval of the Treasury, to make grants from moneys provided by Parliament to the Council of Industrial Design or to any other non-profit-making body, the objects of which include the improvement of design in industry. It is estimated that a sum of £234,000 will be required by the Council of Industrial Design in 1947–48, and that grants to other bodies during that period may amount to £50,000. No estimate for subsequent years can be given, but expenditure in this comparatively new field may well increase. No other charges arise under the Bill, except for administrative expenses.

Gas Turbine Aero-Engine Reliability

WITH the advent of the gas turbine engine, it was predicted that, as development proceeded, gas turbines would become more reliable than piston engines. Complete fulfilment of this prediction can hardly be expected so early in the history of the jet engine; nevertheless, excellent progress is being made by aero-engine manufacturers, notably by Rolls-Royce, Ltd.

In a recent development test, to obtain production clearance for alternative turbine blade materials and to get running experience of the use of neat fuel, that is, without the addition of lubricating oil, a Rolls-Royce "Derwent V" engine was run for over 100 hours. In this 100-hour period 43 hours' running was done at 3000 lb thrust and 20 hours at 3500 lb, and the remaining 37 hours at thrusts varying from 3000 lb to 500 lb.

The test was divided into 20 five-hour cycles, each cycle being run non-stop, separated by long and short cooling periods for the purpose of starting trials. At the start of the test performance curves were plotted for comparison with curves taken after the tenth and twentieth cycles. The figures, we learn, show that in spite of 50 hours' rigorous testing, the loss in engine performance at the end of the tenth cycle was less than 1 per cent of the maximum thrust, and at the end of the twentieth cycle the loss was only 1·43 per cent of the maximum thrust.

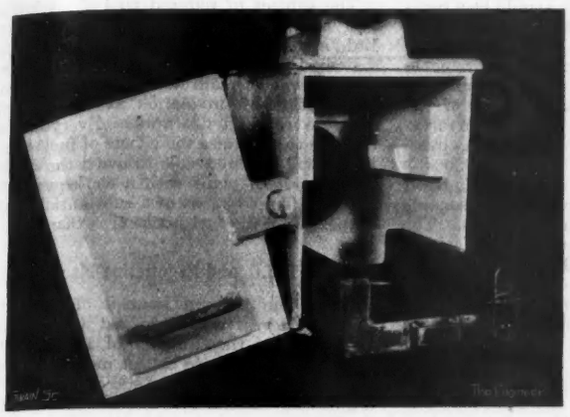
The oil consumption figures were also good; only neat fuel was used, and the total consumption figure for the whole test was 2·25 pints, which gives the low average of 0·0195 pint per hour. This figure is of interest when compared with the oil consumption of a jet engine, when oil is burnt with the fuel and is therefore not recoverable. Hitherto, consumption under such conditions has been of the order of 4 to 5 gallons at cruising thrust. Should the use of neat fuel be accepted by the Air Ministry, it will not only give a useful reduction of oil consumption, but will also save time and manpower when refuelling jet-propelled aircraft.

Included in the test schedules was an overspeed test to prove that the safety factor of the turbine wheel is unimpaired after prolonged periods of running. For this test the engine speed is increased to 3 per cent above the standard combat speed, the actual speed being 15,150 r.p.m. As a result, the jet pipe temperature rises to 706 deg. Cent., that is 26 deg. Cent. above the permissible maximum for service operation, and the combination of increased speed and temperature increases the centrifugal and thermal stresses to figures considerably greater than those encountered in service. Four of these overspeed tests were completed on the test run; it is understood that the engine showed no signs of distress.

Fabricated Steel Plate Axleboxes

To meet the heavy demand for wagon axleboxes, the L.M.S. Railway Company has designed, as an alternative to the standard cast iron and cast steel types, an axlebox fabricated from steel plates.

This axlebox, which takes the R.C.H. standard bearing, liner and lubricating pad,



FABRICATED AXLEBOX

is of simple, all-welded construction, and economical both in manufacture and maintenance. The sides and bottom of the axlebox are formed from rectangular mild steel plates ½in thick, having a back plate ½in thick, cut to such dimensions that when assembled for welding, fillet welds can be made without prior preparation. A hole is cut in the back plate to allow for the entry of the journal and for the usual movements which take place in service.

The top of the box, which has a recess for the bearing spring, is a drop stamping, whilst the two axleguard grooves may be either drop stamped or of rolled section. Two stampings welded inside the box, one on each side plate, retain in position the journal bearing and the liner, which is positioned between the bearing and the inside of the crown of the box. The lid, pressed from ¼in steel plate, is dished to a depth of ½in to give reinforcement, the dished portion having a surround of some ⅝in to face up to the axlebox front.

A lug welded to one side of the lid mates with a similar lug welded to one side plate of the box, and is kept in position by a ½in bolt. This bolt is kept tight by a coiled taper spring under slight compression between the back of the lug on the box and the nut. A stop welded under the bottom plate of the box supports the lid when closed, whilst a stop on the lug side prevents the lid passing its fully open position when inspection is being carried out.

To enable a standard lubricating pad to be readily inserted, or withdrawn, a loose oil container is used, the container and pad being withdrawn together, as necessary.

The oil container, which is made from 14 S.W.G. steel sheet, and welded at the joints, incorporates the "ink well" diaphragm principle necessary to prevent loss of oil when wagons are discharged on rotary or end-tipping appliances. Further to safeguard against loss of oil when tipped, the sides of the container are raised to provide sufficient capacity to retain all the oil at whatever angle the wagon is turned during discharge.

An oil feed hole is located in such a position on the oil container that should the feed hole cover be left open in error, the closing of the axlebox lid will automatically close it.

We are informed that prototype axleboxes have been subjected to the severest shunting tests without damage, while they can be used interchangeably with the standard types. In the photograph we reproduce of one of the new axleboxes, the oil tray is partly withdrawn and the oil feed lid is closed.

Metallic Bellows

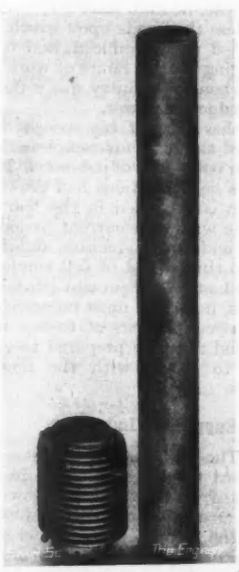
METALLIC bellows formed by a hydraulic method developed by the Clifford Manufacturing Company, of America, are now being made in this country under licence by the Drayton Regulator and Instrument Company, Ltd., West Drayton, Middlesex, and have been given the trade name of "Hydroflex."

This method of making bellows involves the unrestricted flowing of a thin-walled metal tube under hydraulic pressure in a collapsible die. The die consists of a number of plates equal to the number of convolutions, and spaced equi-distant on and surrounding the tube. The metal flows transversely between the plates under this internal pressure, the tube being collapsed endwise as pressure is applied, the bellows thus being formed in one continuous operation.

The advantage claimed for this process is that it proves the product during manufacture, as any tube having a hidden flaw or fault bursts under the high internal pressure.

Both uniform physical properties and uniform wall thickness throughout its length are important factors in determining the resiliency of a bellows, and in the hydraulic method of cold working the unit is kept free from uneven stress distribution.

During manufacture "Hydroflex" bellows are not annealed, as they are formed in one continuous operation from deep-drawn tube to finished product. Physical properties of the



COMPLETED BELLOWS AND ORIGINAL TUBE

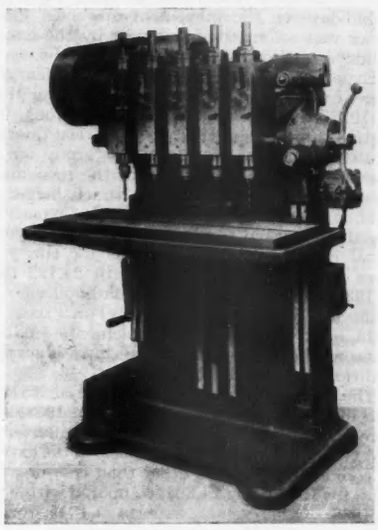
finished bellows are determined by crystalline grain size and by the amount of cold working. Although these properties are extremely critical, they are determined and limited by the corresponding properties of the basic tube, which must conform to very rigid specification if it is to satisfy the requirements of the hydraulic forming process.

In the photograph we reproduce can be seen a completed bellows made by this process and the deep-drawn tube from which it is formed.

A Five-Spindle Drilling Machine

A special machine, built by Adcock and Shipley, Ltd., of Leicester, for drilling holes in steel bars for textile machines, is illustrated in the accompanying engraving. It has five spindles, which are adjustable along the length of the machine, the two outside spindles having a maximum distance between them of 24in. The minimum distance at which any two spindles can be spaced is 3¾in.

The machine is of conventional type, having a rise and fall table, which moves vertically on a box-section column set on a suitable base.



MULTI-SPINDLE DRILLING MACHINE

On the column is fixed the head casting, incorporating a cross rail for the saddles and a driving motor platform.

A 3 h.p. motor drives the main shaft through a vee-belt and stepped cone pulleys, giving three speed variations. The drilling spindles run in ball bearings in the saddles and are driven by hollow-faced spiral gears from the main shaft. The spindle feed racks are cut directly in the quill.

The drill feed shaft is coupled to all the spindles and feed can be imparted by hand from a lever or by an automatic feed mechanism controlled by the hand lever. Pick-off gears are used to set the rate of automatic feed, and an adjustable trip stop is used to determine the depth drilled. The range of gears available and the drive through stepped belt pulleys, gives a selection of speed and feed changes suited to most requirements. If necessary, additional pulleys or pick-off gears can be quickly made to increase the scope of the machine.

All of the saddles are adjustable along the cross slide, over which they can be traversed, through a rack and pinion, to their required positions, where they are firmly locked during drilling.

The table is elevated by means of a crank handle at the front of the machine, and like the column, is fitted with side-locking strips to avoid deflection.

Care has been taken to ensure adequate lubrication throughout the machine. Both the spindle drive gears and the feed worms are immersed in oil. A coolant pump is provided, and the base of the machine is designed to serve as a coolant tank.

U.S. LOCOMOTIVES FOR POLAND.—The Polish State Railway is stated to have placed orders with three firms in the U.S.A. for 100 heavy freight locomotives. Delivery is expected to begin next September, and the locomotives are to be used principally for hauling coal to Baltic ports and other parts of Europe.

Industrial and Labour Notes

Exports in 1946

The Board of Trade has now published a survey of exports of United Kingdom goods during 1946. It shows that, by volume, exports were no higher than in 1938, and it also indicates that the expansion in exports was a good deal more rapid in the first half of 1946 than in the latter half. It should not be overlooked, however, that the figure for the third quarter would have been higher had it not been for the effect of holidays on the movement of goods. This factor was accentuated last year by the longer holidays now common throughout industry.

Exports of iron and steel and manufactures thereof were considerably higher last year than in 1938, the totals being 2,245 280 tons and 1,915 875 tons respectively. In the last quarter of 1946, however, exports in this group fell to the 1938 average. In many of the machinery groups, exports in 1946 were much bigger in volume than in 1938, and here the expansion was more marked towards the end of last year. Total exports of machine tools for the year were 35,449 tons, compared with 24,122 tons in 1938. The export of boilers and boiler-house plant last year was a good deal in excess of 1938, and agricultural implements—mainly tractors, threshers and ploughs—made a notable addition to machinery exports in 1946.

The number of motor-cars exported in 1946 was 69,883, compared with 44,123 in 1938, and here a sharp rise was recorded each quarter of last year. A similar rise took place in the export of commercial vehicles other than tractors, the total for 1946 being 24,801, compared with 3384 in 1938. Other vehicle exports in 1946 worthy of note were 475 main line locomotives, compared with 177 in 1938, and 614 light locomotives, compared with 281 in 1938.

L.N.E.R. Stratford Works Dispute

It was announced on Thursday of last week that the 290 men employed in the Stratford, London, repair depot of the London and North-Eastern Railway had decided to end their "working to rule" which they began on November 25th last. The men agreed to accept an offer, announced at a meeting of the Railway Shopmen's National Joint Council, of a 33⅓ per cent increase on their basic rates of pay.

The decision meant a resumption of overtime and Sunday work, which had been entirely suspended at Stratford since the "working to rule" policy was adopted. The dispute resulted in the cancellation of many L.N.E.R. suburban services from Liverpool Street and Fenchurch Street owing to the fact that about 250 locomotives have been awaiting repair. When the matter was raised in the House of Commons last week, the Parliamentary Secretary to the Ministry of Transport remarked that the cessation of the Stratford dispute would effect considerable improvements in these services, but not immediately. Possibly a couple of months or more must pass before the full effect of the dispute could be overcome and the arrears of maintenance work made up.

Road Haulage Workers' Claim

The Court of Inquiry into the Road Haulage Industry, the appointment of which was recorded in our last issue, presented its report to the Minister of Labour on Thursday of last week.

A statement issued subsequently by the Ministry of Labour said that the Court had expressed the view that the guaranteed week in the road haulage industry should be one of forty-four hours, the wages for the various classifications to be the same as those now paid for forty-eight hours under the current Road Haulage Wages Order. The Court was unanimous in its opinion that the shorter working week was both practicable and equitable in the light of all the circumstances, but appreciated that its introduction could not be effected without some reorganisation. It felt, therefore, that the forty-four-hour guaranteed week might reasonably be introduced within a period ending March 1, 1947. The Court also expressed the opinion that the working week should be a regulated one of either five or five and half days, made up in one or other of the ways set out in the union claim according to the requirements of the various undertakings in the industry. Further, any hours of work in excess of the normal day should not count towards the forty-four-hour week, but should be paid for as overtime. With regard to holidays, the Court's view was that the proposals made by the Road Haulage Central Wages Board were reasonable and equitable in present circumstances. The Court welcomed the setting up of the National Joint Industrial Council for the industry, which, it felt, would be able to deal with the many difficult problems arising from time to time.

The findings of the Court have been accepted by the National Joint Industrial Council for the road haulage industry and by the Road Haulage Association. A delegate conference of the road haulage section of the Transport and General Workers Union, held on Sunday last, also accepted the findings.

The Production Drive

The President of the Board of Trade, Sir Stafford Cripps, addressed a Production Conference at Bradford on Wednesday of last week, and devoted the major portion of his speech to the survey of the country's economic and industrial situation.

Sir Stafford again stressed the fact that if we wanted to get quickly to better and easier standards of living, we must work harder and must patiently be content to take our share of production, without expecting our particular interests to be preferred to those of others. It was of no use, he said, having higher salaries or wages unless the goods upon which they could be expended were produced, and it was of no use arranging shorter hours of work just at the moment when the country was suffering from a lack of productive power.

In another part of his speech Sir Stafford emphasised the need for complete flexibility of outlook on both sides of industry. He said that techniques and traditions had grown up which were essentially rooted in the fear of the old trade cycle with its recurrent periods of unemployment and low production, and if they were applied to this period of full employment and under-production our present efforts would fail. Both sides, he urged, must be prepared to view the new circumstances of to-day with a new outlook and must be prepared to change their methods to fit in with the new economic conditions.

Coal Supplies to Industry

The President of the Board of Trade, Sir Stafford Cripps, was asked in Parliament last week if he had under review the serious situation created in the steel industry in Sheffield by the reduction to 75 per cent of the November coal allocations; and, as this decision forced some firms engaged in steel production to be conducted on the basis of a four-day week, when he hoped to restore coal allocations at least to the November level.

In reply, Sir Stafford said that he was aware of the effect on steel production generally of the recent cut in coal allocations, but, in the present coal shortage, the loss of industrial output must be spread out in order to preserve, as far as possible, the right balance in industry. He was consulting with the Minister of Fuel and Power about availabilities of coal for the coming months, with a view to seeing what future arrangements could be made for supplies to industry, including steel. Sir Stafford added, in reply to further questions, that the matter had been considered extremely carefully but it was no use producing steel if the consuming industries were also falling off in the amount of steel they used. What was intended was to keep a balance between the making and using of steel.

The subject of reduced coal allocations has also been raised by Dorman, Long and Co., Ltd., in a statement issued a few days ago. This statement says that the severe fuel cut will involve, when certain stocks are used up, serious interruption of production at the company's Teesside iron and steelworks. Everything will be done to minimise the effects of fuel scarcity, but it will be impossible to avoid the standing idle of certain plant with a consequent effect upon the employment of a substantial number of men when the fuel stocks are exhausted.

The T.U.C. and Negotiating Machinery

The General Council of the Trades Union Congress was addressed at its meeting last week by the Minister of Labour, and a decision was taken to collect more information relative to the question of speeding-up national negotiating machinery. It will be recalled that the Prime Minister stated in Parliament recently that the adequacy of the existing arrangements for the determination of claims relating to conditions of employment and the settlement of disputes was being examined by the Government.

The T.U.C. General Council also discussed the White Paper dealing with economic considerations affecting the relations between employers and workers. After considering the document as published, the Council confirmed its endorsement of the statement, on the understanding that unions could not be debarred from submitting necessary wage claims.

Manpower and Industrial Co-operation

The Industrial Co-partnership Association was addressed in London on Tuesday last by Sir Godfrey Ince, Permanent Secretary to the Ministry of Labour, on the subject of "Manpower and Co-operation between Government and Industry." He gave an interesting survey of the manner in which the manpower of the nation was mobilised for the war effort, saying that although the Ministry of Labour then possessed powers of control and direction, the advice tendered by such bodies as the National Joint Advisory Council and its Joint Consultative Committee showed the willingness of employers and workers to do everything possible in the national interest.

Sir Godfrey then spoke of the progress made in demobilisation and in the reconversion of industry to a peacetime basis, quoting figures which emphasised the prevailing labour shortage. He went on to stress the need for increased productivity, pointing out that this was a matter which involved men, managements and machines equally. The purpose of the recently issued White Paper had been to present to the country the real facts of the present economic situation so that people could understand them and face them. The problem of what was to be done in the existing circumstances was one which had to be solved without the use of compulsory powers. He believed that the solution could be found by a tripartite co-operation between the State, the employers and the workers.

With regard to the importation of foreign labour, Sir Godfrey said there might be some help from that direction, but recent experience had shown that it was by no means an easy matter. The Ministry of Labour had been endeavouring to get Italian foundry workers into the country. The employers and unions concerned had agreed to this step, but many obstacles over transport, accommodation and other matters had clearly indicated that to obtain large numbers of foreign workers in a short time was not a practicable proposition.

French Engineering News

(From our French Correspondent)

PARIS, January 24th.

The S.N.C.F. is appealing to rail transport users to make every effort to see that trucks are fully loaded, and points out that considerable economy can thus be achieved. Two cases are quoted, one, in which a load of steel bars weighing 25,000 kg was being dispatched from a steel plant to Paris, and two trucks were allocated, each taking 20 tons. The load was equally distributed, and the total cost was 33,614f. instead of 25,414f. for one truck. In the second case two 20-ton trucks were allocated for the transport of 22 tons of soda, at a cost of 46,720f. One truck would have cost 26,106f.

* * *

France is at the moment in the midst of a great reconstruction effort, for which metallurgical products are needed, and at the same time she is making increasing attempts to push exports in order to redress her adverse commercial balance. The need for a definite iron and steel policy is stressed under these circumstances. Since the Lorraine mines were retaken from the Nazis, great production efforts have been made. But the negative results of the years 1940–45 meant that considerable quantities of metallurgical products still have to be imported, though this trade is gradually decreasing and will cease in 1947. By 1950, it is expected that iron production will reach 12 million tons and steel 15 million tons, as compared with 6·137 million tons of steel, 4·243 million tons of sheet iron and steel, and 6·073 million tons of iron in 1938. A delicate situation is expected to arise with regard to iron ore. The eventual disappearance of Germany as a customer and the restrictions placed by Great Britain on imports may, however, be turned to France's advantage if she develops her own productions and exports steel products. Reduction in Germany's industrial capacity leaves an empty place which France is very ambitious to fill.

* * *

It is likely that ore deposits known to include vanadium will again be worked in France. At the time when the mineral was used by the Creusot plant, in about 1900, 60,000 kg of vanadium were obtained a year. It is known that the supply is not exhausted, and similar deposits near Sur are known to contain between 55 and 65 per cent of iron oxide. These minerals will be excellent for the metallurgical industry, and the presence of vanadium gives them an appreciable supplementary value. The Pyrenées iron mines have not fully started to function, but the Algerian mine at Djebel Ali Ben Salah is working and it is known that the ore contains 97 per cent iron oxide. Other mineral sources which are being tapped include manganese in the Aube, molybdenum in the Vosges, and pseudo-bauxite in the Loire. In the Lyons area the old lead, copper and silver mines are to be surveyed.

* * *

The French ball-bearing industry, which suffered considerably from bombardments, has in the past two years recovered sufficiently to be able to produce to-day up to pre-war level, provided the necessary steel is available. Manufacturers generally obtain their steel from two sources—the Ugine and Schneider companies. But in spite of the increase in fine steel production, which has passed the average pre-war level, it is not yet possible to fulfil all the needs of the industry, which is considered a priority one. However, towards the end of 1946 production of steel for this purpose reached a monthly average of 740 tons of bar and 120 tons of tube, and the provision for 1947 is even higher. In addition, imports will provide 7600 tons in the first quarter, and altogether manufacturers will have at least half as much steel again as in 1946.

* * *

The work on the construction of the electric high-tension line linking the Massif Central with Paris has now been completed. The new line will be in service this month, with a tension of 220,000 volts, which in two years will be increased to 400,000 volts.

Notes and Memoranda

Rail and Road

THE TRANSPORT BILL.—The British Road Federation has issued a booklet giving a summary of the Transport Bill. It outlines, without comment, the Bill as it applies particularly to road users. The salient clauses have been grouped under sub-headings, which make for easy reference.

RAILWAY RECEIPTS.—Traffic receipts of the four British main line railway companies and the London Passenger Transport Board for the four weeks ended December 29, 1946, totalled £24,879,000, compared with £25,634,000 for the corresponding period of 1945. Passenger traffic receipts at £14,122,000 were 5·5 per cent less than in December, 1945, merchandise receipts at £7,130,000 were 3·2 per cent less, while coal traffic receipts at £3,627,000 showed an increase of 9 per cent over the corresponding 1945 figure.

ROAD SAFETY EXHIBITION.—A Road Safety Exhibition was opened last week at the London County Hall by the Minister of Transport. It has been arranged by the London County Council in co-operation with the Royal Society for the Prevention of Accidents, and demonstrates very ably many methods and devices by which a high degree of road safety can be maintained. Amongst several exhibits of particular interest to motorists are training devices for testing the reaction of drivers to traffic emergencies and demonstrations in testing brake efficiency.

Air and Water

REPORT ON AIR ACCIDENT IN NORWAY.—The Ministry of Civil Aviation has now issued a report on the investigation into an accident to a British European Airways Corporation Dakota aircraft which occurred near Oslo, on August 7, 1946. The investigation produced no evidence that anything was wrong with the aircraft at the time of the accident. In the opinion of the investigators, the cause of the accident was an error of airmanship by the pilot in that he began his "let-down" too soon. The reason for this error, the report states, must be attributed to inexperience of radio range flying coupled with inadequate aircraft equipment.

JUAN DE LA CIERVA MEMORIAL PRIZE.—The Helicopter Association of Great Britain is offering annually a prize of £25 for an essay or paper of a technical nature, on some aspect of rotary wing flight. The competition is to commemorate Juan de la Cierva and his work in the field of rotary wing flight. The competition is not restricted to members of the Association, but competitors must be British subjects and under the age of 35 years on December 31st, of the year of entry. Entries for this year must be received by March 31, 1947. The subject for competition in the current year is "The Technical and Economic Problems of Rotary-Wing as Opposed to Fixed-Wing Aircraft, and Their Application to the Future of Civil Aviation," and essays are recommended not to exceed 5000 words. Full details of the competition can be obtained from the Secretary, Helicopter Association of Great Britain, Finsbury Circus House, Blomfield Street, London, E.C.2.

Miscellanea

H.R.H. PRINCESS ELIZABETH AND INST. C.E.—H.R.H. Princess Elizabeth has been elected an honorary member of the Institution of Civil Engineers. Her Royal Highness thus becomes the first lady honorary member.

THE LATE MR. C. H. MCLINTOCK.—We record with regret the death, on January 15th, of Mr. Charles Henry McLintock, a director of British Ropes, Ltd., and Ashley Engineering Company, Ltd. He was a partner in the firm of Thomas McLintock, chartered accountants.

THE ALUMINIUM DEVELOPMENT ASSOCIATION.—A booklet has been issued recently by the Aluminium Development Association, setting forth its aims, activities and organisation, and describing some of the work so far accomplished. The booklet emphasises the fact that the Association is a non-trading organisation, existing to co-ordinate effort and disseminate information for the mutual advantage of aluminium suppliers and users. It reveals the many directions in which the Association's advice is given, not only directly to industry, but by co-operation with Government Departments and other technical bodies. The new address of the Association, it may be added, is 33, Grosvenor Street, London, W.1.

THE FERRANTIANS.—Ex-Ferranti men of not less than three years' service are invited to a dinner at the Savoy Hotel, London, on Tuesday, March 11th, to congratulate Mr. V. Z. de Ferranti on election to the presidency of the Institution of Electrical Engineers. Particulars may be obtained from Mr. W. E. Warrilow, M.I.E.E., 24, Bath Hill Court, Bournemouth.

B.E.A.M.A. WELDING SECTIONS.—During the war years the Service Departments and the supply Ministries recognised the immense importance of welding and set up information services to assist users and potential users of welding. The B.E.A.M.A. Electric Welding Sections, which worked in close co-operation with Government Departments during the war, aim to carry on these services and will be glad to provide information on the use of electric welding processes, particularly to firms which are contemplating changing their production to fabrication by welding. The manufacturers of arc welding electrodes and plant and resistance welding machines who are members of B.E.A.M.A. include experts on all matters connected with electric welding. Particulars are available from the Secretary, Welding Sections, the British Electrical Allied Manufacturers' Association (Inc.), 36–38, Kingsway, London, W.C.2.

THE ENGINEERS' GUILD.—The Engineers' Guild, which managed to keep its head above water through the hard years of the war, is now showing renewed vigour. It has just published the first issue of its *Journal*, the principal contents of which are two papers by, we believe, new members. The first of these papers, by Mr. J. H. W. Turner, argues the case for the Guild well and clearly; the second makes a plea for the Registration of Professional Engineers. It was presented by Mr. C. L. Champion. The discussions on both papers are summarised and they show very clearly, by the number of speakers and the range of their comments, that the Guild is full of energy and liveliness. Mr. Turner's paper received, of course, general support, but the meeting was very cautious about registration, and the author himself in his reply to the discussion admitted that the "subject of registration is a long-term one."

CONTINUOUS CAB SIGNALS DISPLAY.—Tests have lately been carried out by the Westinghouse Brake and Signal Company, Ltd., and the L.N.E.R. on the recent extension of the coded-pulse system of track signalling to afford continuous display, in the locomotive cab, of the aspect of the next signal ahead. Pick-up, in this method, is inductive, the energy being amplified and then applied to code-following and decoding equipment on the locomotive of similar type to that already under trial for wayside signals. Although not the first system of cab display, the coded pulse system is expected to offer certain substantial advantages. The most important of these, apart from continuity of display, is that "red" corresponds with non-receipt—from whatever cause—of the pulse codes employed to energise the remaining signal aspects. As with the corresponding wayside signals, it would be an extremely remote possibility that casual interference could so closely mimic any of the pulse codes adopted as to cause a false display.

MINING TIMBER PRICES.—The Board of Trade has made the Control of Timber (No. 45) (Mining Timber Prices) Order, 1947, which came into force on January 27th. The new Order increases the fixed prices for imported mining timber and the maximum prices for home-grown mining timber and provides a price for imported round timber sold by the scale fathom and for home-grown tonnage wood. The new prices are provided in the form of a new First Schedule to the Control of Timber (No. 35) (Mining Timber Prices) Order, 1944, the other parts of which Order remain in effect. In the case of imported mining timber the fixed prices for sales to coal mines and to other buyers are now the same. For home-grown mining timber the new price tables incorporate the increases in cost resulting from the recent increase in the maximum prices of growing trees, and also the price subsidies previously paid to the producers of round mining timber and hardwood sawn mining timber. The maximum prices for home-grown mining timber remain on a delivered basis, but provision is now made for the inclusion in the maximum prices to all buyers of the amount by which the cost of carriage, excluding the cost of carriage by road to rail loading point, exceeds 10s. per ton. In consequence of the above changes the round mining timber price subsidy, the hardwood sawn mining timber price subsidy and the mining timber transport subsidy will not be payable in respect of any timber dispatched on or after January 27th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Tuesday, Feb. 18th.—Lighting Service Bureau, 2, Savoy Hill, W.C.2. "The Electrical Equipment of a Modern Hospital," J. Tomlinson. 6.15 p.m.

Bradford Engineering Society

Monday, Feb. 3rd.—Technical College, Bradford. "Air Conditioning," F. C. Frean. 7.15 p.m.

British Interplanetary Society

Saturday, Feb. 1st.—St. Martin's Technical School, Charing Cross Road, W.C.2. "Interplanetary Flight: Is the Rocket the Only Answer?" A. V. Cleaver. 6 p.m.

Derby Society of Engineers

Monday, Feb. 10th.—School of Arts, Green Lane, Derby. "Production of Armaments by Unskilled Labour," F. Gudgeon. 7 p.m.

Illuminating Engineering Society

Friday, Feb. 7th.—BIRMINGHAM CENTRE: Imperial Hotel, Temple Street, Birmingham. "Some Recent Trends in Daylighting," W. A. Allen. 6 p.m.

Institute of Economic Engineering

Thursday, Feb. 6th.—MIDLAND REGION: Chamber of Commerce, Birmingham. "Time and Motion Study in the Foundry," C. D. Pollard. 7 p.m.

Institute of Marine Engineers

Monday, Feb. 3rd.—SUNDERLAND JUNIOR SECTION: Technical College, Sunderland. "Combustion Turbines," J. Calderwood. 4 p.m.

Tuesday, Feb. 11th.—85, The Minories, E.C.3. "Fundamentals of Ship Stability," J. S. Redshaw. 5.30 p.m.

Institute of Physics

Saturday, Feb. 1st.—S. WALES BRANCH: University College, Cardiff. "Some Applications of Calculating Machines," J. Comrie. 3 p.m.

Institute of Transport

Tuesday, Feb. 4th.—Connaught Rooms, Great Queen Street, W.C.2. Annual luncheon. 12.45 p.m.—MIDLAND SECTION: Imperial Hotel, Birmingham. "Limiting Factors in Co-ordination," C. F. Klapper. 6.30 p.m.

Institution of Automobile Engineers

Tuesday, Feb. 4th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "Road Manners and the Modern Car," M. Olley. 6 p.m.

Institution of British Agricultural Engineers

Tuesday, Feb. 18th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Milking Machines," H. P. Hall. 2 p.m.

Institution of Civil Engineers

To-day, Jan. 31st.—YORKSHIRE ASSOCIATION: Great Northern Station Hotel, Leeds. Twenty-sixth annual dinner. 7 p.m.

Tuesday, Feb. 4th.—S. WALES ASSOC.: Institute of Engineers, Park Place, Cardiff. "Military Railway Bridges Over the Rivers Seine and Maas, 1944–45," Lieut.-Colonel A. R. Pittendrigh. 6 p.m.

Tuesday, Feb. 11th.—S. WALES ASSOC.: Talbot Hall, Mackworth Hotel, Swansea. "The Application of Soil Mechanics to Highway Construction," D. I. Richards. 6 p.m.

Thursday, Feb. 13th.—BIRMINGHAM ASSOCIATION: James Watt Memorial Institute, Great Charles Street, Birmingham. "West Middlesex Main Drainage—Ten Years' Operation," C. B. Townend.

Institution of Electrical Engineers

Monday, Feb. 3rd.—S. MIDLAND CENTRE: James Watt Institute, Great Charles Street, Birmingham. "Engineering Principles Applied to the Design of Domestic Water Heating Installations," R. Grierson and Forbes Jackson. 6 p.m. — N. EASTERN CENTRE (RADIO AND MEASUREMENTS GROUP): King's College, Newcastle-on-Tyne. "A Method of Transmitting Sound in the Vision Carrier of a Television System," D. I. Lawson. 6.15 p.m.

Thursday, Feb. 6th.—Savoy Place, Victoria Embankment, W.C.2. "The British Grid System in Wartime," J. Hacking and J. D. Peattie. 5.30 p.m.

Friday, Feb. 7th.—S. MIDLAND CENTRE: Grand Hotel, Birmingham. Annual dinner. 6.30 p.m.

Monday, Feb. 10th.—N. EASTERN CENTRE: Neville Hall, Newcastle-on-Tyne. "Growing Importance of Plastics in the Electrical Industry," G. E. Haefely. 6.15 p.m.

Tuesday, Feb. 11th.—N. MIDLAND CENTRE: Corporation Electricity Department, Whitehall Road, Leeds. "A Survey of the Development of Radar," R. A. Smith. 6 p.m.—N. IRELAND CENTRE: Queen's University, Belfast. "Industrial Applications of Electronic Techniques," H. A. Thomas. 6.45 p.m.

Wednesday, Feb. 12th.—SCOTTISH CENTRE: Heriot-Watt College, Edinburgh. "A Survey of the Development of Radar," R. A. Smith. 6 p.m.

Institution of Mechanical Engineers

To-day, Jan. 31st.—Storey's Gate, St. James's Park, S.W.1. "The Life of Carbide-Tipped Turning Tools," F. F. P. Bisacre and G. H. Bisacre. 5.30 p.m.

Saturday, Feb. 1st.—YORKSHIRE GRADUATES: Midland Hotel, Bradford. "Heat Treatment," A. D. G. Fitzjohn. 2.30 p.m.

Monday, Feb. 3rd.—N. EASTERN BRANCH: Neville Hall, Westgate Road, Newcastle-on-Tyne. "Mechanical Engineering and Agriculture," S. J. Wright. 6 p.m.

Thursday, Feb. 6th.—YORKSHIRE BRANCH: The University, Leeds. "Research and Development Applied to Bomb Disposal," H. J. Gough. 7 p.m.

Friday, Feb. 7th.—Storey's Gate, S.W.1. "Basic Principles of Automatic Control Systems," A. Porter. 5.30 p.m.

Tuesday, Feb. 11th.—S. WALES BRANCH: Institute of Engineers, Park Place, Cardiff. "Recent Developments in Flying-Boats," H. Knowler. 6 p.m.—MIDLAND BRANCH: Queen's Hotel, Birmingham. Annual dinner. 6.45 p.m.

Monday, Feb. 17th.—GRADUATES' SECTION: Storey's Gate, S.W.1. "The Art and Mechanism of Weaving," Ian S. Porter. 6.30 p.m.

Tuesday, Feb. 18th.—Storey's Gate, St. James's Park, S.W.1. "The Flow of Metals," Dr. A. Nadai. 3 p.m. and 5.30 p.m.

Institution of Mining Engineers

Wednesday, Feb. 12th.—Geological Society, Burlington House, Piccadilly, W.1. Annual general meeting. Paper, "Progress in Coal Preparation Practice," A. Grounds and W. Reed. 11 a.m.

Institution of Production Engineers

To-day, Jan. 31st.—E. COUNTIES SECTION: Lecture Hall, Electric House, Ipswich. "Production Methods as Applied to Machine Tools," T. P. N. Burness. 7.15 p.m.—LINCOLN SUB-SECTION: Technical College, Lincoln. "Education and the Apprentice," E. R. Walter. 6.30 p.m.

Monday, Feb. 3rd.—YORKSHIRE SECTION: Assembly Hall, Grammar School, Keighley. "Production Engineering Research," D. F. Galloway. 7 p.m.—COVENTRY GRADUATES: Technical College, Coventry. Discussion, "The Ideal Training for a Production Engineer." 7 p.m.

Wednesday, Feb. 12th.—LUTON SECTION: Central Library, Luton. "Measurement of Surface Finish," C. Timms. 7 p.m.

Thursday, Feb. 13th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "Cold Forging," C. J. Whitcombe. 6.30 p.m.

Saturday, Feb. 15th.—YORKSHIRE GRADUATES: Great Northern Hotel, Bradford. "Cost Control as an Aid to Management," R. Cooper. 2.30 p.m.

Monday, Feb. 17th.—DERBY SUB-SECTION: School of Arts, Green Lane, Derby. "Motion Study," Miss Shaw. 6.45 p.m.—HALIFAX SECTION: Whiteley's Café, Westgate, Huddersfield. "The Manufacture of Seamless Steel Tubes," J. W. Jenkin. 7 p.m.

Institution of Structural Engineers

Thursday, Feb. 6th.—11, Upper Belgrave Street, S.W.1. "Thermic Drilling of Concrete and Stone," M. Maurice Lebrun. 6 p.m.

Junior Institution of Engineers

Saturday, Feb. 1st.—N. WESTERN SECTION: Geographical Society, 16, St. Mary's Parsonage, Manchester. "Town Planning from the Engineers' Aspect," E. L. Leeming. 2.30 p.m.

Wednesday, Feb. 5th.—MIDLAND SECTION: James Watt Institute, Great Charles Street, Birmingham. Presidential Address, "Power Stations, Past and Present," F. W. Lawton. 6.30 p.m.

Monday, Feb. 10th.—N. WESTERN SECTION: Geographical Society, 16, St. Mary's Parsonage, Manchester. "Starting a Small Engineering Business," F. Burgess. 7 p.m.

Keighley Association of Engineers

Friday, Feb. 14th.—Devonshire Buildings, Devonshire Street, Keighley. "Refrigeration," J. Orpin. 7.30 p.m.

Manchester Statistical Society

To-day, Jan. 31st.—INDUSTRIAL GROUP: Society of Architects, 16, St. Mary's Parsonage, Manchester. "Significance in the Interpretation of Test Data," J. M. Rodgers. 6.45 p.m.

Newcomen Society

Wednesday, Feb. 12th.—Iron and Steel Institute, 4, Grosvenor Gardens, S.W.1. "Malham Moor Mines, 1790–1830," A. Raistrick; and "The Development of the Bessemer Process in Lancashire, 1856–1900," W. M. Lord. 5.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Jan. 31st.—Mining Institute, Newcastle-on-Tyne. "Marine Gas Turbine," Dr. Ad. Meyer. 6 p.m.

Royal Institution of Chartered Surveyors

Monday, Feb. 3rd.—12, Great George Street, S.W.1. "Professional Education," S. J. Worsley. 5.30 p.m.

Royal Institution of Great Britain

To-day, Jan. 31st.—21, Albemarle Street, W.1. "Thin Films on Water," E. K. Rideal. 9 p.m.

Friday, Feb. 7th.—21, Albemarle Street, W.1. "Vitalism: Old and New," James Gray. 9 p.m.

Royal Statistical Society

To-day, Jan. 31st.—INDUSTRIAL APPLICATIONS SECTION: E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Control Charts Applied to Sales Data," B. P. Pudding. 6 p.m.

Rugby Engineering Society

Wednesday, Feb. 5th.—Corporation Electricity Department, Little Church Street, Rugby. "Copper and its Alloys in Engineering," E. Voce. 7.30 p.m.

Sheffield Metallurgical Association

Tuesday, Feb. 11th.—198, West Street, Sheffield. "Trends in Furnace Design," H. Southern. 6.30 p.m.—REFRACTORIES GROUP: Mappin Hall, The University, St. George's Square, Sheffield. "A Statistical Sampling Plan for Refractory Products," W. T. Hale. 7 p.m. (joint meeting).

Stephenson Locomotive Society

Saturday, Feb. 1st.—GLASGOW SECTION: Royal Technical College, Glasgow. "American Locomotive Practice," R. C. Menzies. 7.30 p.m.

Tuesday, Feb. 4th.—BIRMINGHAM SECTION: Chamber of Commerce, Birmingham. "The L. and Y. Railway and its Locomotives," A. H. Bastable. 7 p.m.

Personal and Business

MR. L. ROTHERA has been appointed an executive director of Colvilles, Ltd.

MR. G. R. PARKER has been appointed a director of Fairbairn Lawson Combe Barbour, Ltd.

MR. W. B. JOHNSTONE has been appointed a director of Alexander Stephen and Sons, Ltd.

MR. S. A. BLACKWELL, M.I. Mech. E., has been appointed chief engineer of Wrights Ropes, Ltd., and the Rollason Wire Company, Ltd.

MR. DONALD CAMPBELL has been elected President of the National Federation of Master Steeplejacks and Lightning Conductor Engineers.

MR. J. B. LONGMUIR, general welfare officer to Newton, Chambers and Co., Ltd., has been appointed Director of Welfare by the National Coal Board.

THE VALLEY STEEL AND SPRING COMPANY has moved to Gordon Works, Albert Street North, Newbold, Chesterfield (telephone, Chesterfield 5643).

THOS. FIRTH AND JOHN BROWN, Ltd., announces that Mr. K. W. Phillips has succeeded Mr. H. D. Hewitt as principal representative in the North Midlands sales area.

MR. J. KNIGHT, 21, Wellshot Drive, Cambuslang, Glasgow, has been appointed representative for Scotland of Wycliffe Foundry and Engineering Company, Ltd., and Follsain Metals, Ltd.

THE London Regional Office, Ministry of Works, has changed its address to 8, Cornwall Terrace, Regent's Park, N.W.1 (telephone, Museum 5030; telegrams, "Travauxreg, Norwest, London").

WORKMAN, REED AND CO., Ltd., of Hewish, near Bristol, has been appointed by Associated British Oil Engines, Ltd., sole distributor throughout the West of England for light industrial engines ranging from 1½ to 100 b.h.p.

THE COLONIAL OFFICE announces the following appointments:—Mr. W. P. Steele, superintending engineer, Water Development Department, Tanganyika; and Mr. R. A. Leeming, senior assistant engineer, Trinidad water scheme.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., announces that, in collaboration with its South African agents, E. S. Mowat and Sons, it has formed a company registered as Wild-Barfield (South Africa) (Pty.), Ltd., with offices at 51, Milne Street, Durban.

DR. JOHN ERIC RICHARDSON has been appointed Principal of the Northampton Polytechnic, in the place of Mr. S. C. Laws, O.B.E., M.A., M.Sc., who will retire at the end of March after twenty-two years' service. Dr. Richardson holds the degrees of Ph.D. and B.Eng. of Liverpool and is a member of the Institution of Electrical Engineers, and an Associate Member of the Institution of Mechanical Engineers. He is at present Principal of the Royal Technical College, Salford.

E. H. JONES (MACHINE TOOLS), Ltd., has been appointed agent for "Microset" fine-boring tools made by Austin and Lang, Ltd. By agreement the trade name "Microset" will in future be used only for the products of Austin and Lang, Ltd. This company announces also that E. H. Jones (Machine Tools), Ltd., will in future distribute "Lunzer" high-production rotating centres in London and the southern counties, Warwickshire (except Coventry area) and Lancashire and Cheshire.

Contracts

THE LONDON, MIDLAND AND SCOTTISH RAILWAY announces that a contract has been placed with Pirelli-General Cable Works, Ltd., Southampton, for the provision and installation of thirty-eight pair carrier and voice frequency loaded telephone cables between Euston and Watford, extending to the north end of Watford tunnel, approximately 19 miles from Euston.

THE NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD has placed a contract with the General Electric Company, Ltd., for the manufacture and installation of three vertical-shaft water turbo-alternators with turbines of Boving manufacture for the Errochty power station in the Tummel-Garry scheme. Each alternator will have an output of 27,800 kVA M.C.R. at 11,000 volts, and the Boving turbines a specified rating of 35,000 h.p. against a 525ft head of water. Messrs. Merz and McLellan are the consultants for this scheme, and it is hoped to complete the installation for the winter load of 1948.

Calendars and Diaries

WE acknowledge the receipt of calendars and diaries for 1947 from the undermentioned firms:—

K.L.M. ROYAL DUTCH AIRLINES, Holland.

BUTTERS BROTHERS AND CO., Ltd., Glasgow.

VICKERS-ARMSTRONGS, Ltd., Weybridge, Surrey.

SAUNDERS-ROE, Ltd., 45, Parliament Street, S.W.1.

BRISTOL AEROPLANE COMPANY, Ltd., Filton, Bristol.

C. A. PARSONS AND CO., Ltd., Heaton Works, Newcastle-on-Tyne.

A Seven-Day Journal

Electricity Supply

THE Electricity Commissioners have had under review their procedure for dealing with applications for consent to the use of surplus revenue moneys for capital expenditure. The Commissioners' general consent dated December 19, 1927, to the use of net surplus revenue moneys for capital purposes was, in view of war conditions, withdrawn on September 25, 1939, and since that date it has been necessary for a specific application for consent to be submitted in every case. As indicated in the consent of December 19, 1927, the Commissioners are broadly in accord with the policy adopted by certain local authority undertakers of meeting out of net surplus regularly recurring expenditure on ordinary distribution works and expenditure on comparatively short-lived assets, and the Commissioners have now decided to give a revised general consent (subject to certain conditions) to cover particular items of capital expenditure. The exercise of this general consent is given subject, amongst others, to the limitations that it is not operative in respect of expenditure on generating plant or any other works chargeable to generation capital account; land; buildings, including showrooms and sub-stations, but not including sub-station kiosks; high-voltage mains and ancillary switchgear, transformers and equipment; and application must be made for a specific consent to the application of net surplus to such purposes before incurring expenditure thereon from net surplus.

Commercial and Business Correspondence with Japan

ON Thursday, January 30th, the Board of Trade announced that by arrangement with the Postmaster-General it had issued a General Licence (S.R. & O., 1947, No. 141) authorising business communications of a limited character with Japan. Nothing in the licence, however, authorises trade in goods or the payment or transmission of money or securities. The Supreme Commander for the Allied Powers in Japan is not prepared to allow letters containing powers of attorney, instructions involving the completion of transfers of property within Japan, or information concerning Japanese external assets to be forwarded to Japanese addresses. The control of the Board of Trade through the Trading with the Enemy Department and the Custodians of Enemy Property over Japanese property in the United Kingdom continues in force and is not affected by this licence. British owners who desire to obtain preliminary information on their property in Japan, through official channels, should apply to the Trading with the Enemy Department, 24, Kingsway, London, W.C.2, and should forward to that Department four copies of all letters and enclosures containing requests for such reports for transmission to the occupation authorities in Japan. As pointed out in *The Board of Trade Journal* of December 21, 1946, all trade with Japan is at present on a Government to Government basis, and British traders are therefore advised to apply to the Sundry Materials Branch of the Board of Trade at 10, Old Jewry, London, E.C.2, for advice on whether specific commodities are likely to form part of the import/export programme for 1947, which is now being drawn up by the Supreme Commander for the Allied Powers in Japan.

Manufacturers and the Civil Service

FOLLOWING recent correspondence between the National Union of Manufacturers and the Prime Minister regarding the Civil Service and the Cabinet directive for progressive reduction, the National Union has addressed a further letter to the Prime Minister urging that mere numerical reductions are not enough, and that there is also need for complete revision of functions and methods. The letter states: "The National Union of Manufacturers, following the representations which it recently made to the Prime Minister regarding the Civil Service, welcomes the directive issued by the Cabinet asking Ministries to investigate their staffing requirements with a view to a reduction of 5 per cent in March, to be followed by a further 5 per cent in October. The National Union trusts that the Government will at the same time not overlook the suggestion which it made that a numerical reduction should be accompanied by an investigation into the functions and methods of Government Departments in order to prevent the drain of manpower from industry to the Administration."

Sheet and Strip Metal Users' Conference

A CONFERENCE of the recently formed Sheet and Strip Metal Users' Technical Association was held in London on Friday and Saturday of last week, and was attended by nearly 200 people who showed considerable interest in the practical papers presented for discussion. Mr. W. S. Grainger, Chairman of the Association's Council, presided at the technical sessions of the Conference, and on Friday morning papers were read by Mr. R. G. Harper and Mr. R. S. Strauss, of Fry's Metal Foundries, Ltd., on "Soft Soldering as a Production Process," and by Dr. W. D. Jones, of the Schori Metallising Process, Ltd., on "Flame Spraying by the Powder Pistol." On Friday afternoon Monsieur H. Granjon, a representative of the French Welding Institute, presented a paper on "Methods of Studying the Behaviour of Steel during Welding," which described a localised fusion test of the behaviour of steel during welding. On Saturday morning, two papers were presented for discussion. The first was by Mr. J. W. Sladden and Mr. H. S. Walker, of the Bristol Aeroplane Company, and dealt with "The Development of Zinc Alloy Tools for Blanking, Piercing and Forging Sheet Metal Parts," while the second was by Mr. H. E. Dixon, of Philips Industrial, and was entitled "Some Fundamental Principles for the Resistance Welding of Sheet Metal." The first banquet organised by the Association took place at the Cafe Royal on Friday evening and was well attended by members and guests. Sir Edward Salt, President of the Association, was in the chair, and the toast of "The Association" was proposed by Sir Charles Goodeve, Director of the British Iron and Steel Research Association. He spoke of the many problems of industry which were concerned with the technical efficiency of sheet metal workers, and of the value of co-operative research. Co-operative research, however could not, Sir Charles said, be expected to solve all user problems, and technical progress depended upon the willingness of individual firms to undertake research. Sir Edward Salt proposed "The Kindred Associations," to which Sir William Larke replied, and the toast of "The Guests" was proposed by Mr. Barrington Hooper and responded to by Sir Ernest Fisk.

The Scientific Advisory Council

A STATEMENT, in the form of a written reply to a question in the House of Commons, was made at the end of last week by Mr. Arthur Greenwood on the central Government machinery for dealing with broad scientific questions. During the war, the statement said, there was established a Scientific Advisory Committee, consisting of the officers of the Royal Society and the heads of Government research organisations, which advised the Government on general or specific scientific questions, particularly those affecting the war effort. The Government has had under consideration the permant arrangements for ensuring that, in addition to departmental bodies, there should be available centrally the best scientific advice on the many problems on which it is needed. In addition to the establishment of the Defence Research Policy Committee, the statement continued, it has been decided to set up on the civil side an Advisory Council on Scientific Policy to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy. Sir Henry Tizard, who is Chairman of the Defence Research Policy Committee, will preside over the new Council and the staffs of the two bodies are to work in close association. The Council, the names of which will be announced shortly, will include the heads of the principal Government scientific organisations and a number of scientists from outside the Government service. The statement paid tribute to the work of the outgoing Scientific Advisory Committee which now ceases to exist.

Airedale Foundry, Leeds

AN announcement by Associated British Oil Engines, Ltd., states that one of its subsidiary companies, J. and H. McLaren, Ltd., will in future utilise the Airedale Foundry at Leeds for the production of oil engines. It is also stated that the right to use the name of Kitson and Co., which has been so intimately associated with Airedale Foundry for over a century, has been sold to a firm in Luton. That right, it should be explained, was acquired by J. and H. McLaren, Ltd., when it purchased Airedale Foundry in 1945. Many readers will undoubtedly regret that this latest development at Airedale necessitates the disappearance from Leeds industry of the familiar name of Kitson. Since 1838 until a few years ago, Kitson and Co., Ltd., had built locomotives which have gone to almost every country in the world. Recently, however, the company disposed of its rights to manufacture locomotives, but continued as general engineers and manufacturers of chemical plant. Although oil engine manufacture is now to be a prominent feature of Airedale's activities, work in the boiler shop and in the foundry where iron castings are produced will continue under the name of J. and H. McLaren, Ltd.

International Shipping Conference

AT the International Shipping Conference, which will take place on Tuesday, February 11th, and continue until Thursday, February 13th, at the Chamber of Shipping of the United Kingdom, the shipowners' organisations of the following countries will also be represented:—Australia, Belgium, Denmark, France, Finland, Greece, Holland, India, New Zealand, Norway, Sweden and the United States of America. The Conference has not met for some years, and during the war its work was carried out by the secretariat. The Conference will review the functions which it exercised in pre-war years on matters of technical interest to the industry, such as safety of life at sea, wireless, load-line tonnage measurement, &c., and will consider in the light of post-war circumstances and conditions the procedure which should be followed. It will also provide a medium for the exchange of views on questions which affect the shipping industry generally. It will also consider the question of new membership and will discuss its relations with the inter-governmental consultative organisations recommended by the United Maritime Consultative Council at Washington in November, 1946, and the Social and Economic Council of the United Nations and the International Chamber of Commerce. It is expected that the general question of international co-operation will come up for consideration, and, in addition, the part which the Conference will play as between the shipping industry and the Government on such matters as the safety of life at sea and wireless.

Water Treatment and Filtration Plant at Chicago

By E. E. R. TRATMAN

No. III—(*Continued from page 114, January 31st*)

PURIFICATION of the Chicago water comprises three phases, to be used separately or in combination, according to the varying requirements. First, sedimentation, as follows: The water flows from the raw-water header, which receives water from the pumps, through a venturi meter to a mixing chamber, where the necessary chemicals are applied. Rapid mixing is effected by revolving paddles on shafts parallel with the direction of flow. It goes then through a baffle chamber, 35ft deep, and having obstructions so arranged as to produce additional mixing and also a uniform flow into a double-deck mixing and coagulating basin, which also has revolving paddles. Thence the water enters a long double-deck settling basin, in the first section of which, at both levels, endless chains with scrapers remove the sludge continuously. Finally, the conditioned water passes through a deep chamber where carbon dioxide may be added before the water flows to the filter beds.

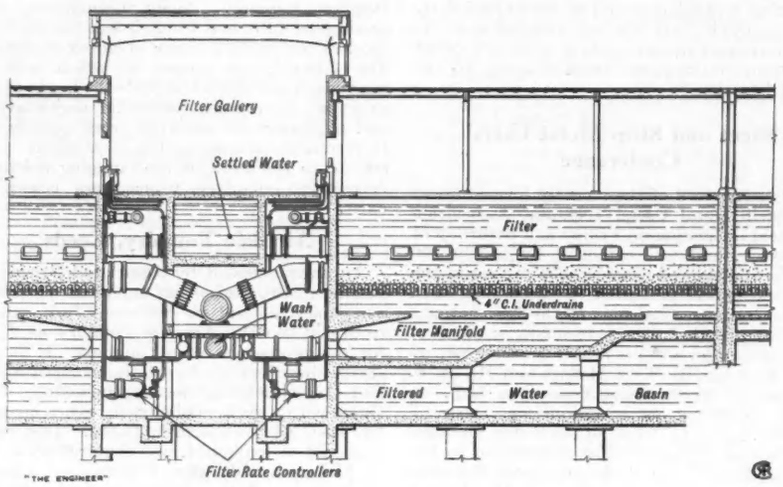


FIG. 10—SECTION THROUGH FILTER BEDS

assisted by the addition of chemicals; second, filtration, and third, chlorination.

SEDIMENTATION TREATMENT

As the Lake Michigan water contains an abundance of micro-organisms which would tend to clog the filter beds with serious rapidity, they must be removed before the water reaches the filter beds. If only a coagulant is used for this purpose, a sedimentation period of 12 to 16 hours would be required, followed by a filtration rate of not more than two gallons per square foot per minute. But, by using lime, partially to soften the water, a sedimentation period of two to three hours will be sufficient for the removal of the micro-organisms. Experiments indicated that this use of lime is more economical than the use of long periods of sedimentation with slow rates of filtration.

Further experiments also showed that a colloidal silicate, produced by treating sodium silicate with an acid and adding this to the water, would strengthen the coagulate or floc and thus increase the efficiency of the sedimentation. It would thus permit the use of higher rates of filtration without danger of the coagulated matter that is carried over to the filter beds passing through the beds. The coagulant may be aluminium sulphate, chlorinated ferrous sulphate, or ferric sulphate.

These basins for mixing, coagulating and sedimentation processes are arranged in three sections or units, as shown in Fig. 2, *ante*, separated by galleries on which are installed the mechanism for operating the mixers, flocculators and sludge scrapers. The three units are parallel and identical, and any two have capacity sufficient to permit a third unit to be put out of commission for cleaning or repair.

In any one of the units, the operation is

Time allowed for the mixing and coagulating period is 50 minutes for the rated capacity of the plant, 320 million gallons daily. In practice, it will range from 45 minutes for an average summer-day rate of 360 million gallons to 35 minutes for the peak-hour demand, at the rate of 460 million gallons. Time allowed for settling will be 3·7 hours for the rated capacity of the plant, or 2·5 hours at the peak rate.

FILTRATION

There are eighty filter beds, arranged in four groups of twenty each, as noted previously, and shown in the general plan, Fig. 2, *ante*. A typical section through the beds and the galleries for the operating apparatus is shown in Fig. 10. This drawing also shows the collecting basins into which the water flows from the filters and from which it flows to the main clear-water reservoir.

Each filter bed is 54ft by 26ft, with a surface area of 1400 square feet and a depth of 11½ft, including the water, which is 7½ft to 8½ft deep above the sand. At the bottom, on the concrete floor, are underdrains of 4in perforated pipe, spaced 12in on centres. The bed itself is approximately 44in deep, composed of sand and gravel in definite layers, from coarse at the bottom, to fine sand at the top. Thus, there is a 6in bottom course covering the drains and ranging in size from 3½in to 1½in. Above this, in succession, are the following: a 4in layer of 1½in to ¾in; a 2in layer of ¾in to ½in; a 3½in layer of ½in to ¼in; a 3½in layer of ¼in to ⅛in; and a 2½in layer of ⅛in to $^1/_{12}$in. The top of the bed consists of 24in of sand of 0·65 mm effective size. With water about 8ft deep above the sand the water surface is 15ft above the lake level.

The filter beds will be back-washed in the usual way by forcing water upwards through them, at an average rate of ten gallons per square foot per minute, for the first part of the washing, and fifteen gallons for the remainder of the time. As the Lake Michigan water has a decided tendency to form mud balls in filter beds, an additional surface washing is provided. This consists of jets at 20 lb pressure, at the rate of three to five gallons per square foot per minute.

On account of the proximity of the bathing beach, the wash water will not be discharged into the lake, but into a group of small settling basins at the south-east corner of the plant, as shown on the plan, Fig. 2.

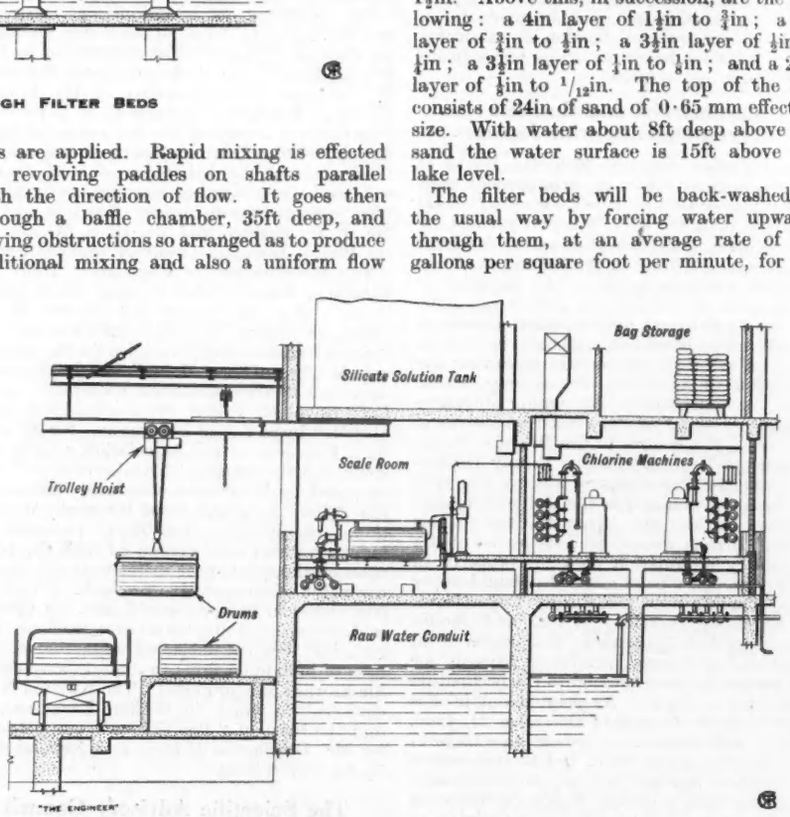


FIG. 11—CHLORINE ROOMS

These basins have sufficient capacity for the wash from three filter beds. The settled wash-water will then be returned by gravity to the raw-water intake basin. The sludge from these settling basins, as well as that from the main settling basins of the conditioning plant, will be pumped into the lake with a discharge about 3000ft from shore. Wash-water pumps deliver water from the clear-water reservoir to an elevated tank of 300,000 gallons capacity, giving sufficient pressure for the filter washing service. This tank also supplies water for the chemical treatment processes, and for high pressure flushing and general plant service.

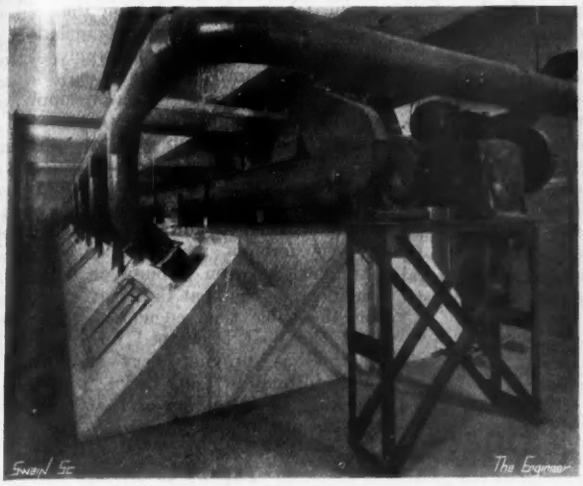


FIG. 12—CONVEYORS IN CHEMICAL BUILDING

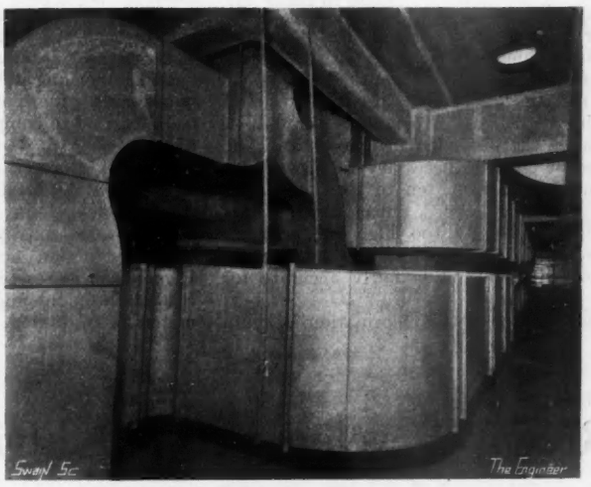


FIG. 13—VENTILATING CONDUITS IN CHEMICAL BUILDING

CHEMICALS

Handling, storage, preparation and feeding of the numerous chemicals required for regular or occasional use are provided for in the chemical building. These chemicals include the coagulants, aluminium sulphate, chlorinated ferrous sulphate, and ferric sulphate; also lime, sodium sulphate, sulphuric acid, powdered activated carbon, chlorine and ammonium sulphate.

Chemicals in bulk, as received by rail in box wagons, are unloaded from the wagons by pneumatic apparatus, as shown in Fig. 8. For chemicals delivered in iron drums by railway wagon or motor lorry the drums are handled by trolley hoists on overhead runways, as shown in Fig. 11. To avoid a dusty condition in the chemical building, an elaborate ventilating and dust removal equipment is provided. In Fig. 12, the pipe and spiral conveyors are shown, while Fig. 13 shows the air conduits of the ventilating system.

Average annual proportioning of chemicals, as required to meet the varying characteristics of the water, is estimated in the table herewith, the four materials marked with an asterisk being alternatives for occasional use, according to market prices and other conditions.

Sodium silicate will be pumped from railway tank wagons to three 20,000-gallon storage tanks and thence transferred to 35,000-gallon tanks, to be diluted with water to a 50 per cent solution, which, in turn, is to be pumped to 26,000-gallon tanks, for treatment with sulphuric acid and further dilution. This weak colloidal solution will then flow through automatic flow regulators into the raw water. Lime, alum and iron compounds and ammonium sulphate received by rail in bulk wagon loads, are unloaded by pneumatic and screw or spiral conveyors and delivered to steel storage tanks or bins, from which the materials flow by gravity through weighing hoppers to the chemical feeders.

The dry chemical feeders, except the lime feeders, discharge into tanks for dilution to a weak solution that flows into the suction well of the low-lift pumps. The lime feeders discharge into continuous slakers, which are fed with water through measuring devices, and from which the milk of lime flows into the raw water. Activated carbon, received in bags, will be emptied as needed into steel bins, through the special apparatus for dust elimination. Chlorine is received in one-ton containers and fed to the raw water in a water solution through fourteen chlorinators of the vacuum-feeder type.

FIG. 14—BATTERY OF CHLORINATORS

Chemical Requirements for Water Treatment

	Parts per Million	Pounds per Million Gallons
Alum or iron	6·8	56·7
Lime	12·5	104·0
Activated carbon	7·0	58·3
Chlorine	0·6	5·0
Ammonia, anhydrous*	0·2	1·7
Ammonium sulphate*	0·8	6·7
Sodium silicate*	5·0	41·7
Sulphuric acid*	0·5	4·2

CHLORINATION

As explained previously, the chlorine treatment may be applied either as an independent process or as supplementary to filtration. At present it is the main treatment, pending completion of the filters. The chemical may be applied at various stages in the flow of water through the plant. A battery of the chlorinating machines in the chlorination room is shown in Fig. 14.

Actual operation of this comprehensive water treatment plant under present conditions, with the filtration still awaiting completion of the filters, has been described substantially as follows by Mr. W. W.

DeBerard, city engineer of Chicago, in a paper before the American Society of Civil Engineers:—The main chemical treatment now is chlorination and coagulation with aluminium sulphate, with an acid-treated sodium silicate being used to some extent. A small amount of lime is also used occasionally.

For chlorination, the practice is to add sufficient chlorine to the water just ahead of the three raw-water venturi meters, at the mixing basins, to produce residual chlorine of at least five pounds per million gallons in the water leaving the plant. The dosage of chlorine necessary to obtain this residual varies from ten to twenty pounds per million gallons. Since the residual chlorine is usually too high for accurate testing with orthotolodin the starch-iodid method is used and is fairly accurate for high residuals.

Close control of the chlorination is maintained, because much now depends on the effectiveness of the chlorine to produce a water of suitable bacteriological quality. Should insufficient chlorine be applied in advance to the raw water at the meters, an additional amount is applied in the outlet shaft of the treated water or clear-water reservoir. Later on, most of the post-chlorination will take place in the filtered-water headers leading to the reservoir.

This important and extensive work for the purification of a polluted water supply is being carried to completion under the direction of W. W. DeBerard, city engineer, with F. G. Gordon, assistant city engineer, and John R. Baylis, engineer of water purification. John S. Dean, engineer of water works construction, has charge of the construction activities, with Carl G. Riggenbach as resident engineer. The total cost of the plant and its accessories is estimated at £6 million.

Recent Developments in Flying Boats*

By HENRY KNOWLER†

No. III—*(Continued from page 118, January 31st)*

Methods of Handling

THIS brings me to the handling of flying boats, both on the water and on land. At this time military flying boats are not provided with docks at the main operating stations, but are either tended at their moorings or hauled ashore on beaching chassis. The chassis is designed to float at a convenient height so that attachment is facilitated and is strutted to strong points on the hull. The wheels are usually in pairs, are steerable, and are frequently fitted with brakes for ease of handling on the ground. Attempts have been made to provide floating docks, but these have not so far come into general use, as it has been found more convenient to beach the machines.

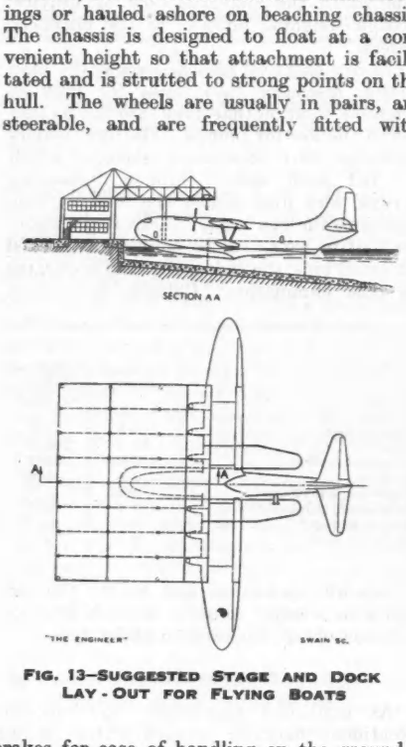


FIG. 13—SUGGESTED STAGE AND DOCK LAY-OUT FOR FLYING BOATS

Civil flying boats, on the other hand, have been provided with landing pontoons, although, generally speaking, these have been rather primitive due to operating companies being unwilling or unable to spend money on more elaborate equipment.

The British Overseas Airways Corporation (B.O.A.C.) has recently provided floating landing stages at Southampton which are a considerable improvement. They are very suitable for handling passengers, but fall short of what is desirable. These landing stages in form are U-shaped pontoons sliding in fixed guides with gangway connection to the shore. This arrangement, however, is of a temporary nature, merely to serve until proper seadromes become available, where permanent landing stages and docking facilities can be provided.

Fig. 13 gives a picture of the type of stage and dock arrangement which is desirable, at least at the base, but preferably at all main stations *en route*.

Covered decks should be used so that disembarkation of passengers, luggage and freight can be carried out under cover. Inter-flight maintenance, refuelling, &c., must be rapidly carried out, the various services being plugged into connections on the boat. With this type of dock, engine-changing would also be greatly improved, as it would be an easy matter to provide lifting arrangements from the roof.

It will be seen that the boat is warped under the hangar roof between stages at a convenient height for disembarkation. The passengers alight on the port side, all dock services being operated from the starboard side. The facilities would include high-delivery refuelling main, oil supply, electrical connections into the machine's circuits, sewage extractors, fresh water supply, conditioned air supply and a compressed air supply, so that, when required, pressurised boats can be tested on the water for air-tightness. The method of handling boats in and out of dock is being investigated by Saunders-Roe. An automatic hook is attached to the forefoot which picks up a cable stretched between a buoy or dolphin and the dock as the boat taxies over it. A stop on the cable then engages with the hook and the boat is warped into dock. This method is proving very successful and will ultimately cut down the time of docking to a fraction of that needed with the old methods.

Trends in Design

I have so far confined my Lecture to current practice in flying boat design. I should now like to turn to the trends in design, and perhaps peep a little into the future.

I have shown earlier in my Lecture that increase in size has advantages in almost all respects, and that to fly great distances in the minimum time with a satisfactory paying load a large machine is essential. To meet these requirements, large aircraft are now being developed, such as the Bristol "Brabazon I," the Consolidated "C V.37," and the Lockheed "Constitution," all of which are landplanes, and also my own firm's flying boat the "S.R.45."

A few notes on the latter machine are perhaps not inappropriate, and will be useful in illustrating the type of flying boat which will be used in airline operations in the immediate future (Fig. 14). The machine is required for the direct transatlantic flight from England to New York. This is probably the worst route in the world, not so much because of the distance, which is 3450 miles, but because of the very high adverse winds which blow from the west throughout the year. For instance, on the outward journey, flying at 35,000ft, in order to maintain an 85 per cent frequency of service during the winter months, allowance must be made for

FIG. 14—MODEL OF "S.R. 45" FLYING BOAT

* Institution of Mechanical Engineers. January 17th, Thomas Lowe Gray Lecture. Abstract.

† Chief designer, Saunders-Roe, Ltd., East Cowes, Isle of Wight.

head winds up to 80 m.p.h. over the whole journey; moreover, icing conditions are frequent in winter, and low visibility is common at the terminal bases. To meet these adverse winds and to cover route diversions and other allowances, a still air range of 5000 miles is necessary. A high cruising speed is specified. To obtain this, and to provide overweather flying, the flying boat will operate at from 35,000ft to 39,000ft altitude, at a speed of over 350 m.p.h. The weight of the machine at take-off is 290,000 lb, carrying eighty-four passengers and 3000 lb of mail. The power required for take-off is 30,000 h.p., which will be supplied by six propeller turbines.

The hull is pressurised to a working pressure of 8 lb per square inch. The cross section consists of two intersecting cylinders with an upper deck at the junction, and a pressurised lower deck cutting the bottom cylinder, which is supported against internal pressure loads by the planing bottom frames and structure. This form of hull is very suitable for a flying boat, as the required floor area is obtained on a relatively deep body, which has the advantage of raising the wing and propellers well above the normal spray height.

The materials used are extruded sections in high-tensile aluminium alloy with an ultimate tensile strength of 35 tons per square inch, and alloy sheet with a tensile strength of 27 tons per square inch. Main frames are spaced at 28in intervals, and the whole surface is supported on stringers spaced at between 7in and 8in. A section amidships is shown in Fig. 15.

The body is developed from two cylinders, the upper 11ft 3in in diameter and the lower 14ft 6in in diameter. It is parallel for 45 per cent of the hull length on the upper deck and 60 per cent on the lower. The overall dimensions of the hull are—Length overall, 147ft; main and aft planing bottoms, 63ft and 56ft respectively; and the maximum beam, 16ft 6in.

The main step on this machine is elliptical in plan, and has a dead rise of 25 deg., with a slight flare at the chine. This flare increases forward towards the bows, but is omitted on the aft bottom. The dead rise aft of the step is increased to 35 deg., so as to clear the main step spray.

The weight of the wings when on the water, about 80 tons, is distributed fore and aft on two main frames, and is carried through to the rest of the structure without use of bulkheads. A clear space is thus provided throughout the lower deck.

The pressurised part of the hull extends nearly the whole length, but the part intersected by the wing and the bow compartment in the lower deck are outside the pressure region. Great care is necessary to make the joints in the plating, as well as all doors and openings, as airtight as possible, since, with such a large volume an accumulation of minor defects may prevent the building-up of the pressure as required. The pressure supply is completely duplicated. It is pumped by two-stage centrifugal blowers driven off the main turbines. Each blower is capable of supplying 1500 cubic feet of air per minute at 8 lb per square inch pressure from an ambient pressure of 3 lb per square inch and a temperature of −70 deg. Fah. at an altitude of 39,000ft. This air is conditioned before delivery into the hull to a temperature of about +70 deg. Fah. and 40 per cent humidity. As the ambient humidity at great heights is negligible, a considerable weight of water must be carried for this purpose.

When used on tropical runs a refrigerator and dehumidifier are added. This plant works on the air cycle system. The air from the main compressor is cooled and passed through a free-running coupled compressor and expansion turbine, and a second stage of cooling is interposed between the second compressor and the turbine. The energy lost in driving the turbine is expressed by a considerable drop in temperature.

The Saunders-Roe flying boat is fairly conventional in form, although advanced in detail design. As practical engineers, you will appreciate the necessity for step-by-step advancement in almost any branch of mechanical science, and will know that success seldom follows startling novelty.

After all, the machine should be the servant of man, and improvements when made must not be accompanied by undesirable features. For instance, there may be the possibility of increased speed by the use of a new device, and there are many innovations in the early development stage; but if the device introduces added danger to the passenger or if it reduces comfort, its advantages may not be worth while.

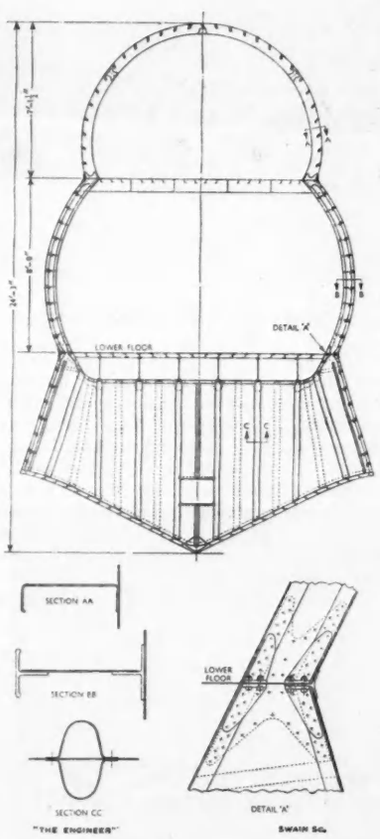


FIG. 15—SAUNDERS-ROE "S.R. 45" FLYING BOAT: SECTION AMIDSHIPS

In the end the customer gets what he wants. In air travel the real customer is the passenger; not only does he want to travel rapidly between places a great distance apart, but he wishes the journey to be as comfortable and enjoyable as possible.

I would therefore place comfort before other considerations, and much development in the immediate future, I feel sure, will be made in this direction. Secondly, I would place cost of operation. Again it is the customer who decides. He may be able to reach New York from London in six hours, but the cost may be prohibitive.

Although no doubt many will disagree with me, I put time of journey third. You will appreciate that the elapsed time on the journey is the important consideration, not the speed of flight.

These three considerations—comfort, cost and time of journey—point to development in size, for reasons which I have already mentioned, and, needless to say, my view is that, at least for long trans-ocean journeys, this can only be attained by the use of flying boats.

The increasing size of landplanes involves larger and stronger runways. A given runway is only suitable for one maximum size of aircraft, and an increase may involve not only lengthening, but extensive reinforcing against concentrated wheel loads. For instance, it is reported that the London airport (Heathrow) is only suitable for a 360,000 lb machine with individual wheel loadings of 90,000 lb.

Flying boat landing is not restricted to a comparatively narrow runway about 200ft wide, which at times may be out of wind, since landing can be made in any direction, and the width limitation hardly exists.

American and European nations are mainly concerned with communications over land within a continent. The British Empire's communications radiate outwards from England with long ocean crossings. Forced landings are not unknown in spite of multiple engines. Who, therefore, would not choose to be in a flying boat if such a contingency should arise?

Diversion from the main alighting base is impossible with big landplanes, which require special runways; but a flying boat can alight almost anywhere. Even a forced landing over land is safer in a flying boat than a landplane; indeed, such landings have been made several times without serious damage.

The cost of initiating a service is not purely the provision of aircraft, but includes the ground facilities. Landplanes and flying boats are very similar in cost for comparable sizes, but the provision of landing and handling facilities is very different. The relative cost of long runways and the acquisition of land compared with flying boat facilities is very striking indeed, involving millions compared with a few thousands of pounds for the latter.

In what direction other than size increase will flying boats develop? My opinion is that, in order to provide pay-load capacity and the comfort I have promised, and to obtain satisfactory hydrodynamic properties, the hull will be retained; that is, the flying wing will not be used.

The hull, in form, will be long and narrow, and may be without steps and have only rudimentary chines. The wing will have low aspect ratio, will be heavily tapered, and have very thin sections. It will also have heavy sweep-back. I think there will be a fairly large tail and fin, for control and stability reasons.

This aircraft, of the not-far-distant future, will be propelled by axial flow jet turbines, but some form of augmentation of power will be used for take-off and initial climb. It will be necessary to fly this machine at a considerable height, probably about 50,000ft, and a speed of 500 m.p.h. is likely to be developed.

This may be the future flying boat in outline, but to fill in the details is not so easy, as it involves developments in directions only now being investigated.

Worshipful Company of Shipwrights' Exhibition

No. II—(*Continued from page 125, January 31st*)

IN this article we continue our review of the Worshipful Company of Shipwrights' Exhibition.

JOHN SAMUEL WHITE AND CO., LTD.

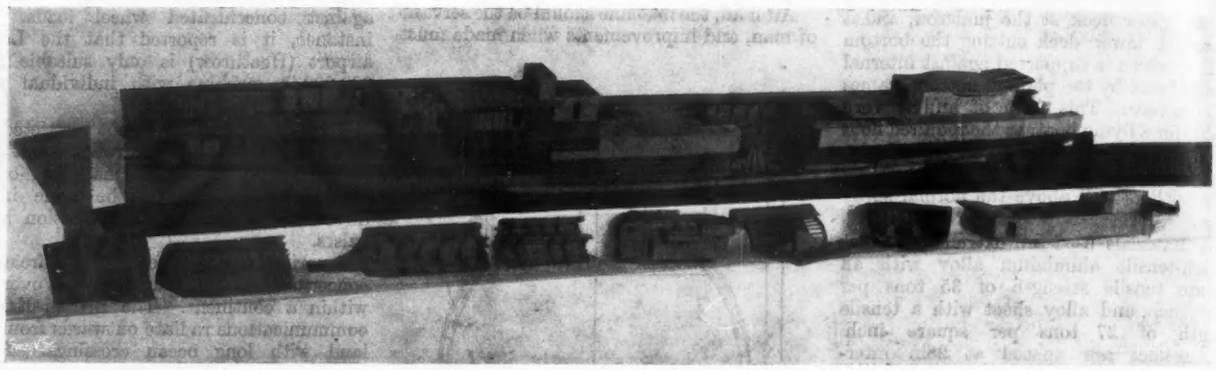
Models of considerable interest to welding engineers are to be found on the stand of J. Samuel White and Co., Ltd., of East Cowes, Isle of Wight. There is a model of the shipyard, a structural model of the all-welded destroyer, H.M.S. "Contest," illustrated herewith, and a model of the completed ship. Construction methods for all-welded destroyers now building for the Admiralty are shown, with examples of welded construction.

This welding work was begun late in 1942, when, after long discussions with the Director of Naval Construction's Department at the Admiralty, in which both Sir Stanley Goodall and Mr. Lillicrap took part, it was decided that the firm should investigate the possibilities of successfully building all-welded destroyers. Work had already been done on bulkheads and decks associated with oil tanks, and more extensive welding had been applied in the construction of the minelayer "Abdiel." At an early stage it was decided to adopt prefabrication and to break away from existing destroyer building practice. This meant extra work in the drawing-office to determine the extent of welding, sizes and weights of welded units, &c., and the preparation of detailed drawings. Welding personnel was increased and finally about 100 men and fifty women were employed on welding, with the requisite supervisors. As a result of a bombing attack early in 1942 much of the yard and shops had been destroyed, and it was rebuilt to suit prefabrication methods and the use of "Unionmelt" automatic welding machines in the shops and later on the berths. "Monotower" fixed and travelling cranes were installed to handle up to 8 tons. Shop procedure, erection work on berths and fitting out afloat were all designed to fit in with prefabricated methods. Methods of testing and examination of welds were adopted and included radiographic examination of trepanned sections.

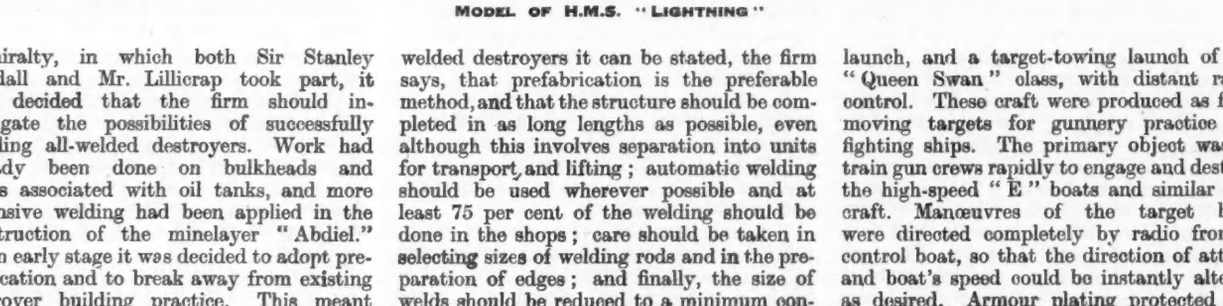
After experience with seven or eight all-welded destroyers it can be stated, the firm says, that prefabrication is the preferable method, and that the structure should be completed in as long lengths as possible, even although this involves separation into units for transport and lifting; automatic welding should be used wherever possible and at least 75 per cent of the welding should be done in the shops; care should be taken in selecting sizes of welding rods and in the preparation of edges; and finally, the size of welds should be reduced to a minimum consistent with strength, and intermittent welding used wherever possible so as to minimise distortion and locked-up stresses. The reports of vessels launching, docking and in commission all show that the original basic principle of prefabrication was correct. This principle seems likely to be adopted as standard by the Admiralty for all future destroyers.

JOHN I. THORNYCROFT AND CO., LTD.

The range of models displayed on the stand of John I. Thornycroft and Co., Ltd., of London, Southampton, Reading and Basingstoke, is designed to show the wide range of the firm's products, but by exhibition regulations are confined to naval vessels. An interesting model, illustrated below, on one end of the stand is that of the No. 1 torpedo boat of the British Navy, H.M.S. "Lightning," built and engined by the firm in 1876. On the opposite end of the stand is a fine model, illustrated herewith, of a modern destroyer, H.M.S. "Brecon," of the "Hunt" class. These two ships show the striking development in destroyer design in the last seventy years. Other ships shown in model form include the H.M.I. sloop "Narbada," an L.C.M. landing craft, a motor torpedo boat, an air-sea rescue launch, a harbour defence motor launch, and a target-towing launch of the "Queen Swan" class, with distant radio control. These craft were produced as fast-moving targets for gunnery practice for fighting ships. The primary object was to train gun crews rapidly to engage and destroy the high-speed "E" boats and similar fast craft. Manœuvres of the target boat were directed completely by radio from a control boat, so that the direction of attack and boat's speed could be instantly altered as desired. Armour plating protected the vital equipment of the target boat, such as the engine, the fuel tanks and d.c. radio



MODEL OF H.M.S. "CONTEST"

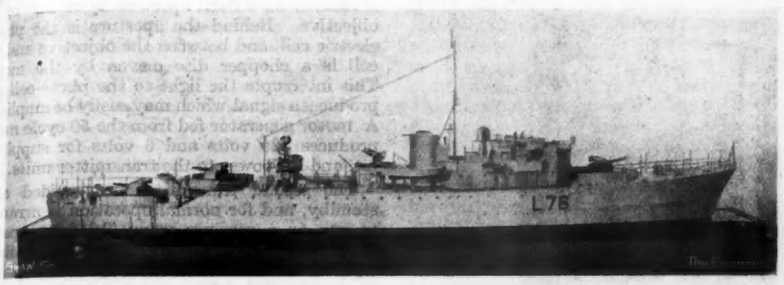


MODEL OF H.M.S. "LIGHTNING"

equipment, and special buoyant material was fitted round the hull to prevent the boat from sinking below the gunwale after being hit.

John Stone and Co., Ltd.

On the stand of J. Stone and Co., Ltd., of Deptford and Charlton, a range of windows and sidelights of various kinds for ship use is displayed. Drawings are also on view of the firm's electrically controlled water-tight bulk-head door system, which is now being installed in a number of important



Model of H.M.S. "Brecon"

ships, both built and building. It provides for the closing control at a central position of all the water-tight doors fitted in the bulkheads, and at the same time provides for the local operation of each door by a 2 h.p. water-tight reversible compound motor working on a 220-volt circuit.

Other drawings illustrate the Stone's Monoflow underline sewage expeller system, which is now being fitted in the ships "Nova Scotia" and "Newfoundland," under construction at the Walker Yard of Vickers-Armstrongs, Ltd., for the Johnston Warren Lines, Ltd. Each unit is designed to discharge below the water line up to 1½ tons of sewage or waste water per minute. It is very simple in operation and can be fitted to any convenient place in the ship below the water line. A model of a "Heliston" propeller as fitted to the "Queen Elizabeth" and "Queen Mary" is shown on the stand, which typifies many propellers, some 22,000 of which have been supplied by the firm. Drawings are shown of the Stone controllable-pitch propeller, and we understand that the firm is now engaged on an Admiralty order for several such sets of controllable-pitch propellers. The firm is also showing examples of Y alloy aluminium pistons, 17in diameter, for submarines.

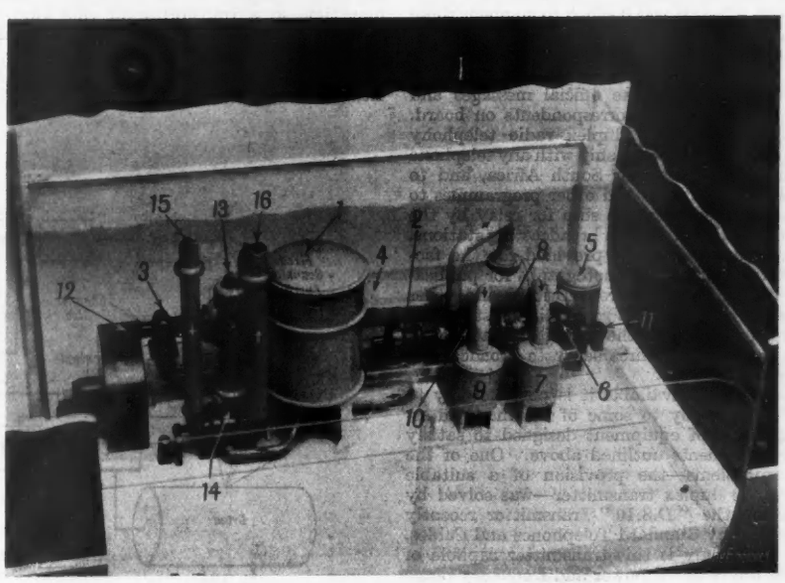
John Brown and Co., Ltd.

On the stand of John Brown and Co., Ltd., of Clydebank and Sheffield, is seen the largest model in the exhibition, that of the Cunard White Star liner "Queen Elizabeth." It has a length of 18ft and shows much of the detail of the ship. Another interesting model is that of the Cunard White Star liner "Media," recently launched and now fitting out at Clydebank. She has a length of 534ft and a measurement of 13,700 gross tons. A further model shows the "Essex," one of two sister motor vessels operated by the Federal Steam Navigation Company, Ltd., in the refrigerated and direct cargo transport between this country and Australia. She has a measurement of 11,000 tons, a length of 551ft and was built in 1936.

A model, illustrated herewith, of unusual interest is that of a gas turbine installation of John Brown-Escher Wyss closed cycle turbines designed for a cross-Channel ship. For simplicity only one shaft is shown. The one shaft unit has a designed output of 6000 s.h.p. The high-pressure and low-pressure turbines are on different shafts, the high-pressure turbine being utilised to drive only the compressors at a constant speed, while the low-pressure turbine supplies 6000 s.h.p. for propulsion through gearing and a variable-pitch propeller.

The accompanying engraving shows the method of operation. The air in the closed cycle enters the air heater 1 and passes through numerous small tubes which are heated by the combustion of oil fuel. In the heater the gases of combustion do not mix with the closed cycle air, which passes out at a temperature of 1200 deg. Fah. and goes to the h.p. turbine 2, seen to the right of the air heater. Exhausting from the h.p. turbine, the air passes to the l.p. turbine 3, shown at the back to the left of the air heater. This turbine drives a variable-pitch propeller through reduction gearing 12. The air is exhausted directly from the l.p. turbine to the long heat exchanger 4, to be seen at the back of the set. In the exchanger the residual heat remaining in the exhaust air is used to raise the temperature of the compressed air on its way to the air heater. After leaving the exchanger the air passes through the pre-cooler 5 on the extreme right, in which it is cooled to a low temperature by sea water. It now enters the air compressors 6, 8, and 10, in which in three stages its pressure is raised from 90 lb to 340 lb per square inch. It is intercooled between these stages in the intercoolers 7 and 9, which will be seen in the foreground of the set. The geared starting motor 11 is for the compressors. The high-pressure air is led by the overhead pipe to the right hand of the heat exchanger 4, in which it flows towards the left, through numerous very small tubes. Emerging from the left hand end of the exchanger, it passes to the air heater, thus completing the cycle. As only pure air passes through the turbines, the compressors and the heat exchanger, there is no danger of deposits and the heat exchanger tubes can be made comparatively small in diameter. The output of the plant is conveniently controlled by varying the pressure and hence the density of the air in the closed circuit. Manœuvring in this particular installation will be carried out by a John Brown-Escher Wyss variable-pitch propeller, the reduction of the load on the turbine being controlled, if only for short duration, by by-passing some of the air past the turbine. The combustion space within the air heater is raised to a pressure of about 30 lb per square inch, the combustion air being compressed in a supercharging set, the turbine of which is driven by the exhaust gases from the air heater. The air inlet duct 15, the exhaust duct 16 and the combustion air preheater 13 with the supercharging set and its starting motor can be seen in the model. A portion of the exhaust gases is recirculated to the air heater by means of a fan, incorporated in the supercharging set, in order to reduce the temperature in the combustion chamber without having to use a large quantity of excess air.

The estimated efficiency of this installation is 31 per cent, based on the higher calorific value of a heavy grade of boiler oil. This closed cycle type of turbine is suitable, it is pointed out, for larger powers, and 50,000 s.h.p. is within its range. Above 8000 s.h.p. the air would be reheated between the h.p. and l.p. turbines, and with air at a maximum temperature of 1200 deg. Fah. an efficiency of 34 per cent should be obtained. With the high temperature resisting metals now available a life of upwards of 100,000 hours could be expected.



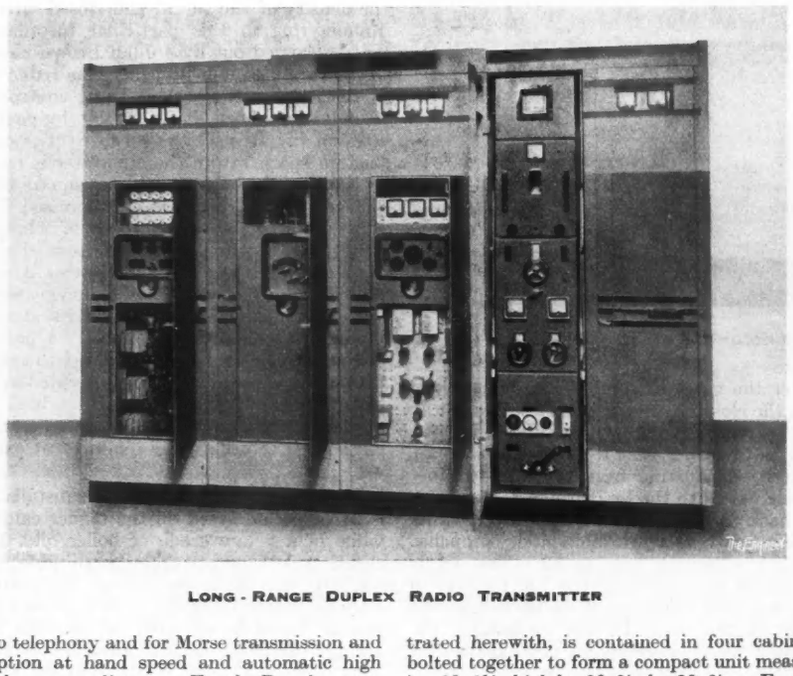
Model of Gas Turbine Installation for Cross-Channel Ship

Other models on the stand show the detailed construction of the John Brown-Escher Wyss variable-speed propeller, "Perspex" hubs permitting the manner in which the blades are controlled to be seen.

(To be continued)

Radio Communication Equipment in H.M.S. "Vanguard"

WHEN H.M.S. "Vanguard" was completed early last year she was fitted with a battleship's normal radio communication equipment, which is limited to that needed for short-range radio telephony and for Morse transmission and reception at hand speed and automatic high speed over any distance. For the Royal voyage to South Africa it was decided to augment these normal services with a number of additional facilities. First, duplex automatic telegraphy (*i.e.*, a two-way radio teleprinter line) was installed to handle the official messages and copy from the Press correspondents on board. Secondly, long-range duplex radio telephony was provided to link the ship with any telephone extension in Britain or South Africa, and to enable commentaries and other programmes to be transmitted from the ship for relay by the B.B.C. and South African broadcasting stations. Thirdly, apparatus was provided for the facsimile transmission of photographs for publication in the Press of Great Britain and other countries. Fourthly, a rediffusion system was installed throughout the Royal compartments, giving a choice of three separate broadcasting programmes.



LONG-RANGE DUPLEX RADIO TRANSMITTER

In the space available it is possible only to refer very briefly to some of the many interesting items of equipment designed to satisfy the requirements outlined above. One of the main problems—the provision of a suitable long-range duplex transmitter—was solved by installing the "D.S.10" transmitter recently developed by Standard Telephones and Cables, Ltd. Not only is this transmitter capable of giving the required power and frequency range on radio telephony, but, being designed particularly for marine use, the installation of the apparatus between decks proved to be relatively simple.

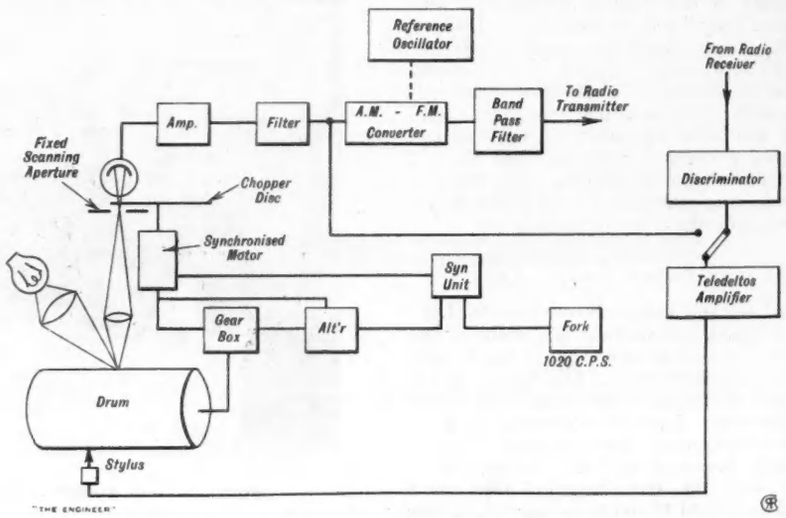
The transmitter can be operated either (*a*) on two c.w. channels at 5-kW each or three c.w. channels at 3 kW each, with independent keying; or (*b*) on two c.w. channels at 3 kW each with common keying; or (*c*) on one c.w. channel at 3 kW plus one telephone channel at 3 kW. Alternatives (*b*) and (*c*) permit simultaneous transmission on two different frequencies within the range of 2·5 mc/s to 22 mc/s. An electronic keying unit is incorporated and the set can be operated at any keying speed up to 600 words per minute. As installed in H.M.S. "Vanguard," the transmitter embodies two complete r.f. units, together with one modulator and the necessary power equipment. The whole assembly, illustrated herewith, is contained in four cabinets bolted together to form a compact unit measuring 6ft 6½in high by 9ft 3in by 3ft 2in. For the first time in a transmitter of this kind, the valves are cooled by air blast provided by three blowers.

For picture telegraphy, Muirhead and Co., Ltd., Beckenham, Kent, was invited by the Admiralty to design and produce apparatus which would operate in conjunction with the ship's normal radio transmitter, and would provide a service of Press pictures between the ship and this country during the cruise. The equipment installed consists of duplicate transmitter units assembled with the associated electronic equipment on three standard 19in racks. The system employs sub-carrier frequency modulation and feeds directly into the normal amplitude modulated ship's radio apparatus. A picture measuring 8in by 5in can be transmitted in 12 min.

Basically, each transmitter unit consists of a Muirhead-Belin portable transmitter, mounted on a shelf in front of the racks, and connected by flexible cables to the electronic equipment. As illustrated herewith, the transmitter comprises a low-voltage driving motor geared to the main lead screw carrying the drum on which the material to be transmitted is clipped. The speed of the motor is controlled by a valve-maintained tuning fork (frequency 1020 c.p.s.), so that the drum rotates at 1 r.p.s. and is traversed to give a scanning of 135 lines per inch. The scanning spot is illuminated by a small projector lamp and an image of this spot is focused on a fixed aperture by means of an objective. Behind the aperture is the photo-electric cell, and between the objective and the cell is a chopper disc driven by the motor. This interrupts the light to the photo-cell and produces a signal which may easily be amplified. A motor generator fed from the 50-cycle mains produces 180 volts and 6 volts for supplying h.t. and l.t. power to the transmitter units.

The second transmitter is provided as a standby, and for normal operation is arranged to run as a receiver using Teledeltos paper. For this purpose a spring-loaded insulated stylus has been added to it, which presses on to the Teledeltos paper mounted on the drum. The signal voltage is applied to the stylus, and the signal current burns the paper by an amount varying with the signal and so produces a picture. This picture does not, of course, compare in quality with a photographic reproduction, but is quite suitable for monitoring purposes.

All the electronic equipment, with the exception of the photo-cell amplifier which is mounted on the actual transmitter, is assembled on three standard racks. Two of the racks are identical and carry the transmitter equipment. The centre rack contains the equipment for reception on the monitoring receiver, including a discriminator unit and a Teledeltos amplifier; in addition, this rack carries switching and terminal arrangements, a telephone and a loud-speaker. The accompanying diagram shows that the picture signal from the photo-cell, which comprises a 4800 c.p.s. carrier modulated 0 to 1000 c.p.s., is passed through a high-pass filter, which removes unwanted frequencies below 2500 c.p.s. From the filter the signal is passed to an amplitude-modulation/frequency-modulation convertor. In this unit the signal is first demodulated and filtered to remove the 4800 c.p.s., and the resulting signal of 0 to 1000 c.p.s. is applied to the reactance tube proper, where it varies the oscillator frequency so that the output frequency varies between the limits 1600 c.p.s. to 2000 c.p.s. A modified Muirhead-Wigan decade oscillator is provided as a reference oscillator for setting up the limits on this unit. The output from the converter



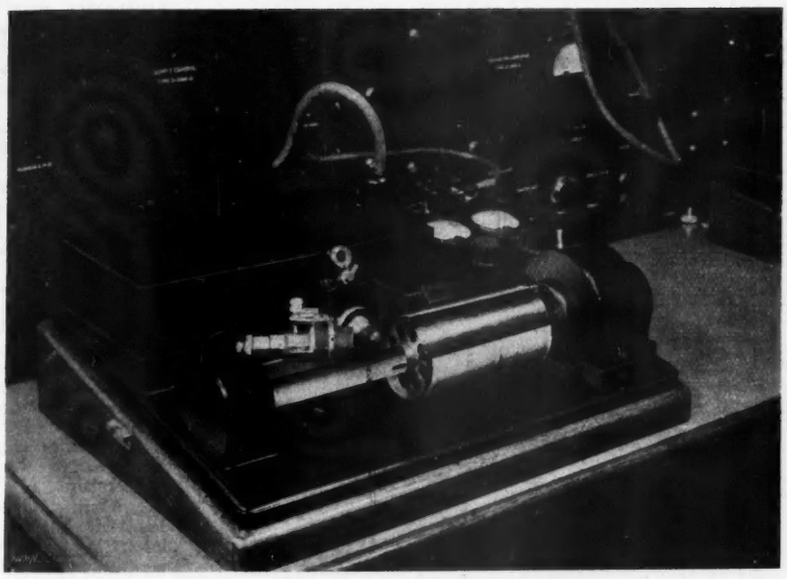
BLOCK SCHEMATIC DIAGRAM OF PICTURE TELEGRAPH EQUIPMENT

unit is fed through a band-pass filter, with pass limits of 800 c.p.s. to 2800 c.p.s., to the radio transmitter.

The monitoring picture receiver receives a signal from a radio receiver through a discriminator and the Teledeltos amplifier. Alternatively, the Teledeltos amplifier may be fed directly from the signal at the input of the A.M./F.M. converter, or from the input to the radio transmitter.

For the rediffusion of broadcast programmes three standard naval receivers are arranged to feed loud-speakers fitted with a selector switch in each of the cabins at the disposal of the Royal party. One of the major technical problems associated with these arrangements is that of eliminating interference from the ship's transmitters. The design and disposition of suitable aerials and the use of filter circuits therefore received special attention. All the transmitting aerials are arranged on the main mast, while the receiving aerials are rigged on and around the foremast and are connected by feeders to the receivers which are housed in the special control room and in the ship's normal receiving rooms. This arrangement provides a separation of only 100ft between transmitting and receiving aerials. To increase this separation, four additional receiving "whip" aerials have been installed—two forward on the forecastle and two aft on the quarter deck. When it is desired to broadcast from the ship a commentary on some particular event, it may happen that conditions at the time may prevent the establishment of a satisfactory radio-telephone link with a shore station. The B.B.C. has therefore provided disc-recording equipment, which is installed in a recording room in the bridge structure, so that the broadcast can be transmitted when conditions are favourable.

The automatic telegraphy service to and from the "Vanguard" is being operated with



PICTURE TRANSMISSION

naval shore wireless stations in the United Kingdom and in South Africa. The other special facilities are being worked with G.P.O. stations in the United Kingdom and to the Cape Town terminal of Cable and Wireless, Ltd., of South Africa. In the United Kingdom the "Vanguard" circuit can be connected from the G.P.O. overseas terminal in London as required by lines to subscribers' telephones, to the B.B.C. or, in the case of facsimile transmission, to Electra House, the London headquarters of Cable and Wireless, Ltd., which operates this system in the United Kingdom.

All this special equipment was installed, whilst the "Vanguard" was undergoing conversion for the Royal cruise, by the Admiralty and the Admiralty Signal Establishment at Haslemere, with the co-operation of the G.P.O., Cable and Wireless, the B.B.C. and the manufacturers of the equipment used. The Navy awaits the results with keen interest, since, apart from meeting the operational requirements of the Royal voyage, invaluable experience will be obtained towards the solution of the many problems involved in providing such facilities in other warships. Automatic telegraphy for ships is as yet in its infancy. Long-range radio telephony has only been introduced into one or two warships during the last couple of years, and, as far as is known, this will be the first occasion on which a fascimile service has been provided from a ship.

The Electricity Bill*

MR. SHINWELL: I submit that whatever Government had assumed office in July, 1945, would have been compelled to introduce long-overdue legislation to reorganise the distribution side of the electricity supply industry. That is expected by everyone in the industry. Even private companies are well aware that the present state of affairs cannot be left unchanged, although, of course, their intensive and expensive propaganda suggests that all would be well if they were allowed their own way.

For many years there have been constant complaints of the extraordinary variety of charges in electricity supply and the basis on which those charges are fixed is often obscure. I am satisfied that this public service must do everything possible to rationalise its method of charging. That is not possible so long as there are 563 undertakings, each possessing rights in its own area. Not only must the method of charging be standardised, but also the supply itself. The only part of the supply that has been standardised is the frequency at the generating stations, which was provided for in the 1926 Act. Many undertakings still provide both alternating and direct current, and there is a great diversity of voltages. It will be agreed that the sooner this standardisation is carried out the better, and that can only be effected by undertakings operating over wide areas with adequate resources and with far-reaching plans for development.

The Authority and the Boards

The Bill provides that the British Electricity Authority shall have full responsibility for the generation of electricity and its sale in bulk for public supply. The Government suggest, however, that the British Electricity Authority should not undertake the detailed work of local distribution. Electricity is an all-pervading service, and if it is to be satisfactory we must maintain the closest contact with local requirements, together with a sense of local responsibility. I propose, therefore, that there shall be created fourteen area boards, the boundaries of which I have indicated in the White Paper issued with the Bill. The British Electricity Authority will be responsible for the general policy affecting distribution and will be the sole body in the industry with powers to raise capital. It is proposed, however, that each area board, within limits assigned to it, should have freedom to carry on its detailed work without reference to the Central Authority. It is far from my desire that problems which can be settled locally shall be taken to London. I am satisfied that the provisions of the Bill provide area boards with sufficient scope.

It is essential that the area boards and the Central Authority should learn to understand each other and work in the closest co-operation. The Bill therefore provides that four chairmen of area boards will be appointed as members of the Central Authority, this membership moving in rotation among the chairmen. The fourteen chairmen will have four representatives on the Central Authority capable of expressing their view and also informing those chairmen on the general policy of the Central Authority. This will, in itself, lead to unity of interest between the Central Authority and the area boards, which will make for close and harmonious working. Naturally, the Bill provides that the Minister shall be empowered to give directions on matters of national interest, and, when necessary, these directions will be given to the Central Authority. It will be their task to translate them into suitable terms for transmission to the area boards.

The area boards will divide their areas into districts and appoint appropriate officers. Each area board will be a very large undertaking, and I am anxious that consumers of electricity should not feel that they are dealing with a body which is remote and aloof from their problems.

Consultative Councils

I therefore propose that in each area there shall be set up a consultative council. Most of the members of these consultative councils will be nominated by the local authorities and other members will be nominated by representative associations, including trade unions. The councils will have wider functions than consumers' councils. They will be associated with the work of the area boards, be advised on its plans and will examine these plans in the light of their knowledge of local interests and requirements. The councils are authorised by the Bill to create such local machinery as may be necessary to keep them informed of requirements in all districts in their areas and full publicity will be given throughout the areas to the existence and location of the consultative councils. By this means, I hope that the consumers everywhere will feel that they are dealing with organisations which are responsive to their requirements.

Improvement of Distribution

As the House will observe, the Bill provides that the British Electricity Authority can raise for purposes of development, capital to the amount of £700 million and in the case of the North of Scotland Board to the value of £100 million. There is no fixed period in which it is estimated this development will be undertaken. It depends upon whether physical resources permit the work to be carried out. It is esti-

* Extracts from the Debate in Parliament, Feb. 3rd.

mated that of the £700 million, at least £200 million will be required for power stations alone.

About £400 million will be required for improving the distribution network and a substantial proportion of that will be used in the development of supplies to the countryside. The new boards will be able to undertake rural development on a national and systematic plan and, unless it is proceeded with quickly, I am satisfied there is no hope of checking the decline in the rural population. In agriculture, electric power can play as great a part as it can in industry, and with the shortage of manpower in agriculture intensified electrification is imperative. The Central Authority and the area boards will spread throughout the whole country the high standard of service which at present is confined to a number of undertakings. They will then proceed to improve those services and bring them up to the highest standard of efficiency. There is a vast field of work to be undertaken, and I have every confidence that the arrangements set out in the Bill will enable the boards to carry out the work.

The Opposition

Mr. R. S. Hudson: I suggest to the House that anyone defending this Bill ought to endeavour to show what benefits to the consumer will flow from the measures proposed in the Bill. I suggest that two things are then necessary. It is essential to show positively that the benefits will be greater than those which reasonably could be expected to accrue from the present development plans, both of private companies and of municipalities; secondly, it is essential to show that those benefits will outweigh the disadvantages which are bound to result from the dislocation of the industry. I want the House and the public to remember that the benefits, if any, that accrue from the Bill will be benefits only in the future, whereas the dislocation, and disadvantages that follow from dislocation, must be endured in the present. Whether the right hon. gentleman could have chosen a worse moment than the present in which to precipitate dislocation, I leave to the judgment of the country.

The right hon. gentleman made a great play with the diversity of charges to-day. What he did not tell the House is that a committee to go into this matter was set up by the Central Electricity Board at the instance of the companies concerned and, if the rumours I hear are correct, that committee is about to report and, without this Bill, a substantial measure of simplification of charges would come into operation this year.

Consumers' Interest

The right hon. gentleman attached some importance to the consumers' interest. I suggest that there is a complete absence of any protection for the consumer in this Bill. We should not forget that we are concerned with the provisions of the Bill and not with what the right hon. gentleman thinks may happen. Under Clause 33, for example, to whom are tariffs left? The right hon. gentleman did not mention that tariffs are left to the decision of the area boards. There is no provision, such as existed in the past, in the case of haulage charges in the Railway Rates Tribunal, now known as the Railway Tribunal, and perpetuated in the Transport Bill. In other words, the consumer is at the mercy of the area boards. Some play was made by the right hon. gentleman with the fact that there were to be consultative councils. We should have a good deal more faith in the efficacy of these councils—again I am only dealing with what is in the Bill—first, if they had any effective executive power; and secondly, if they were appointed by outside bodies, and were not to be merely "stooges" of the Minister.

Rural Charges

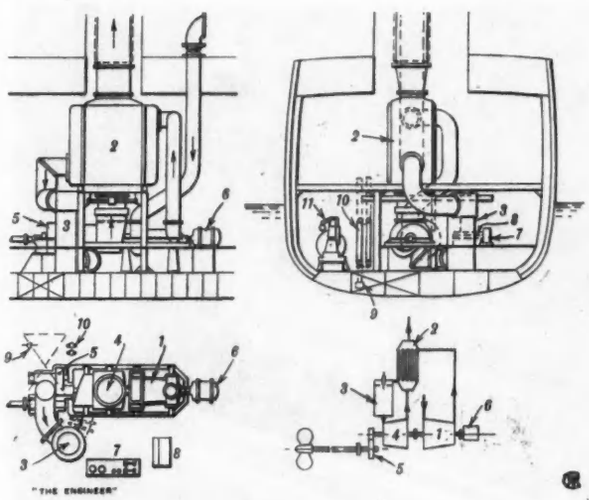
I would ask the right hon. gentleman, in view of his statements about what is going to follow from this Bill, whether he suggests that, when this Bill is passed, and the new electricity authority takes over, rural charges would be brought into line with urban charges? What is the right hon. gentleman going to spend on rural electrification? Will he abolish installation charges? Will the Government give priority to the provision of electricity in rural areas? The truth is that the right hon. gentleman does not know the answer to any of these question. At any rate, he did not give them in his second reading speech.

To sum up, this Bill is one more example of the Government's passion for over-centralisation. It is not only an attack on a decentralised industry, but two-thirds of it is an attack upon non-profit-making local authority enterprise. It is a Bill to give more power to the Minister, and more jobs to the "boys." Many of its provisions are grossly unfair and unjust to large numbers of people, hitherto directly and indirectly connected with the industry, whether they are directors, managers, employees, shareholders or ordinary ratepayers. Many of its legal provisions abolish rights which have been regarded hitherto as part of the inalienable heritage of the British people, not only here, but overseas, in countries which have taken British ideas of justice as the basis for their law. Finally, of all the nationalisation measures hitherto introduced by this Government, this will do the most harm to that revival of industry and that increase of production to which so many right hon. gentlemen pay lip service, but, alas, only lip service. It is for all these reasons that I move that this Bill be read this day six months.

Marine Gas Turbine*

By Dr. AD. MEYER

To-day, after seven years, it seems appropriate to consider in the light of past experience whether the hopes set on the gas turbine as a marine engine can be justified. Generally speaking, the gas turbine has the same advantages and disadvantages as the steam turbine.



	a	*b*
Specific fuel consumption, lb per s.h.p.h.	0·588 ...	0·602
Thermal efficiency, per cent	25 ...	23·2
Specific weight, lb per s.h.p.	63 ...	—

a As tendered. *b* At 68 deg. Fah. temperature of intake air and 5·5 square feet per s.h.p. surface of heat exchanger.

1. Air compressor.
2. Heat exchanger.
3. Combustion chamber.
4. Gas turbine.
5. Reduction gear with thrust block.
6. Starting motor.
7. Fuel pump and filter.
8. Control station.
9. Lubricating oil pump.
10. Lubricating oil cooler.
11. Auxiliary diesel engine.

Fig. 1—*Gas Turbine Set of 2000 s.h.p. for a Cargo Ship*

Disadvantages.—Neither type of turbine is suitable for direct propeller drive so that gear drive or electric transmission has to be adopted to reduce the turbine speed to a speed suitable for the propeller. The turbine is not reversible, and therefore an astern turbine or reversible propeller is required unless electric transmission is adopted embodying reversibility independent of the turbine. Further, the gas turbine is not self-starting, because a given volume of air at a suitable pressure is necessary for starting and a starting motor of a capacity of about 5 per cent of the full-load output is required.

Advantages.—Due to the high speed, turbine machinery has less weight than reciprocating engines. It is more suitable for large outputs. Having an even turning moment the operation is smoother and less supervision and maintenance are required. As compared with an internal combustion engine, the turbine can be operated with lower-priced fuel oil. Compared with the steam turbine the gas turbine has the great advantage of simplicity.

The combustion turbine requires no boilers, no feed pumps, no feed-water treatment, which under prevailing and future conditions of pressure and temperature is almost a science, no feed heating, either through economisers or bled steam, no superheaters, no condensing plant with its auxiliaries, such as circulating condensate pumps and air ejectors.

The only auxiliary machines required are the compressor, the starting motor referred to above, the lubricating oil and fuel oil pumps. To these must be added the combustion chamber and, if high efficiency is aimed at, the air intercoolers for the two-stage compressor and the air heaters.

It may be argued that the compressor is really a main machine and not an auxiliary. At a gas temperature of 600 deg. Cent. (1112 deg. Fah.) at the turbine inlet, the compressor absorbs three-quarters of the total turbine output, so that only one-quarter of the turbine output is available as net output. It must, however, be kept in mind that the whole of the energy absorbed by the compressor does not present a loss. Almost all of the energy absorbed by the compressor appears as heat in the air for combustion and cooling. But this amount of heat is generated with the efficiency of the process as a whole and could be more economically generated by fuel in the combustion chamber. As the net output is equal to the difference between two much larger values of energy, it is evident that the efficiencies of the compressor and turbine have considerable bearing on the overall efficiency. In fact, an improvement in the turbine efficiency of 1 per cent affects the overall efficiency by 4 per cent, and a similar improvement in the compressor efficiency by 3 per cent.

The above figures refer to a working temperature of 600 deg. Cent. (1112 deg. Fah.) at the turbine inlet. If higher temperatures can be used, less secondary air will be required for a given quantity of fuel for the purpose of cooling the products of combustion and the power requirements of the compressor will drop. This leads to an increase in the net output and the efficiency (Fig. 2).

It was the application of aerodynamic research to turbine and compressor design and the availability of improved heat-resisting materials which enabled a satisfactory gas turbine design to be developed ten years ago. Since then further progress has been made which permitted the increase of both its range of application and its commercial possibilities. Up to date, no gas turbines are in use for ship propulsion.

I propose to deal first with the most simple

* North-East Coast Institution of Engineers and Shipbuilders. Abstract.

arrangement that can be applied to a vessel, *i.e.*, a single-stage arrangement with a variable-pitch reversible propeller. This is shown in Fig. 1. The proposal was for a freighter of 2000 s.h.p., and the figure shows the general arrangement of the various parts.

Air compressed to a suitable pressure is supplied by the compressor 1, passes through

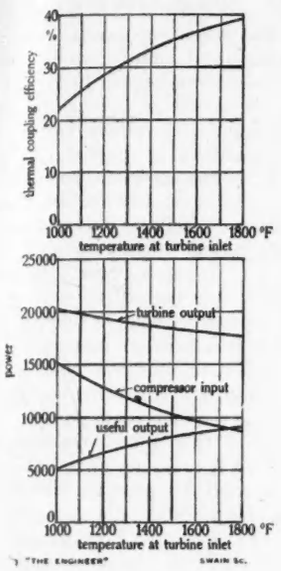


FIG. 2—*Effect of Working Temperature on Efficiency and Power*

the heat exchanger 2, where it is preheated, then to the combustion chamber 3, where it serves as primary air for combustion and as secondary air for cooling the gases. The latter then enter the turbine 4 at a temperature of 600 deg. to 650 deg. Cent. (1112–1200 deg. Fah.). From the turbine exhaust the gases pass at a temperature of about 400 deg. Cent. (752 deg. Fah.) to the heat exchanger 2, resulting in an appropriate drop in temperature. A single-stage installation of this type without heat exchanger will have an efficiency at the propeller shaft of 18 per cent, rising to 28 per cent with a suitable size of heat exchanger. This corresponds to an improvement of fuel-oil consumption from 350 to 220 gr or 0·775 lb to 0·486 lb per s.h.p.-hour.

It may be mentioned that the gas turbine is the only prime mover that can be built in such large measure as a simple low-priced machine for low efficiency or as a machine of high efficiency though more expensive, permitting the unit to be easily adapted to widely varying conditions. In a steam turbine installation, for instance, any reduction in price made at the expense of efficiency is counterbalanced by the heavier and more costly boiler and condensing plant, resulting from the increased steam consumption.

The gases exhaust to atmosphere at a temperature of about 200 deg. Cent. (392 deg. Fah.), the air being delivered at a temperature of 120 deg. Cent. (248 deg. Fah.) from the compressor.

The methods of starting such a plant are as follows :—

It is assumed that the oil in the fuel tanks has been heated from an outside source to the required temperature (such sources being mentioned later on). The lubrication oil pump is started up first. This pump must be of larger capacity than the corresponding pump in a steam turbine installation on account of the higher operating temperature. For starting the set the auxiliary diesel has to be started unless current for the starting motor is taken from the ship's service generators. It is, of course, immaterial whether d.c. or a.c. is used, and this will depend solely on the type used for the ship's services. The power required for starting is about 5 per cent of the maximum output of the turbine. The set is then run up to the required ignition speed, *i.e.*, the speed at which the compressor supplies a sufficient quantity of air for combustion and cooling to run the set. Ignition is effected by an electrically heated rod or spark. The motor may then be switched off and uncoupled. On the other hand, we usually design the motor electrically for the ignition revolutions and output, but mechanically for the maximum revolutions of the group, so that the motor can be permanently coupled to the shaft. Then only the electric supply has to be switched off on reaching ignition speed. On a ship it may be advantageous to use the starting motor as a generator to provide electricity for the ship's auxiliary services, once the gas turbine is started and in service. This can be done by using a d.c. motor with two windings and separate excitation.

The whole starting process occupies about 10 min. and the vessel is now ready to proceed by manipulating the propeller angle. In the technical Press starting times of more than two hours have been given. We have found that it is possible to start up a 15,000 h.p. unit in 6 min. and repeat this as often as necessary without any visible or detrimental effect.

By altering the blade angle of the propeller and suitably modifying the supply of fuel to the combustion chamber, the whole speed range ahead or astern can be obtained. At partial loads it is important in the interest of economy to keep the speed of the turbine as low as the propeller permits. The characteristic curve of this type of propeller shows the minimum number of revolutions for any given load. It is therefore possible to design a control gear enabling the three controlling factors of fuel quantity, air quantity and angle of propeller, to be varied with one lever in their proper proportions for the maximum attainable efficiency at any particular output. There are no critical speeds over the whole range of operation.

Other parts of the installation which have so far not been mentioned deserve attention.

The airlet duct to the compressor, although passing a large quantity of air, is not unduly large, the section per 1000 h.p. being about 2¼ square feet.

The compressor is sensitive to dust and dirt. Consequently care is necessary to see that there is no oil leakage from the bearings. The air at sea will be free of dust, so that no special air filter is required. On the other hand, experience will show whether salt particles carried over by air may stick on the blades and have an injurious influence.

The heat exchanger receives the air from the compressor at a temperature of 120 deg. Cent. (248 deg. Fah.). The compressed air is heated by the turbine exhaust gases which are at about 400 deg. Cent. (752 deg. Fah.) to about 320 deg. Cent. (608 deg. Fah)., and are expelled to atmosphere at about 200 deg. Cent. (392 deg. Fah.). The preheater is therefore not exposed either to excessively high or very low temperatures, and the temperature in service never drops below the dew point. As the pressures are also quite moderate and no part is highly stressed, ordinary welded commercial steel tubes can be used.

Combustion Chamber.—Efficient and smokeless combustion of the fuel oil depends upon the correct proportions and design of the combustion chamber. Excess of primary air results in grey smoke indicating unburnt oil due to too low a temperature. Black exhaust is the result of unburnt carbon due to insufficient primary air. With the large volume of air available for cooling the gases it is not difficult to obtain perfect combustion.

For starting combustion the oil has to be preheated. If no source of heat such as, for instance, steam from a donkey boiler is available, it is necessary to start the unit on diesel oil which need not be preheated and to change over to the heavier oil when sufficient heat is available for preheating the oil. This can be achieved by the use of an exhaust heat boiler in series with or parallel to the heat exchanger. The degree of heating will depend on the grade of oil. It may occasionally be necessary to change over from oil of a certain quality to another grade of oil, which entails a readjustment of the proportion of primary to secondary air for which the adjustment of flaps inside the combustion chamber is required. Omission to do so in the case of the gas turbine locomotive, when a change was made from gas oil to ordinary bunker oil, resulted in a fire in the heat exchanger. A change in load requires no adjustment as long as the air quantity is reduced with falling load, which is in any case necessary in order to obtain good efficiency at partial load.

Faulty combustion may also occur due to coke or dirt in the nozzle of the burner. By avoiding exposure of the nozzle to excessive radiation and by employing only a single burner for all loads with a moderate oil pressure of about 25 kilos per square centimetre (356 lb per square inch), such troubles can be avoided. The usual rough and fine oil filters have to be used.

[Detailed descriptions of the more elaborate arrangements mentioned in Table I followed.]

Table of Proposals Described

Type.	s.h.p.	Drive.	Speed turbine/ propeller.	I as tendered			II.	
				Fuel consumption, lb per s.h.p.h. per cent efficiency.	Weight, lb per s.h.p.	Space, cub ft per s.h.p.	Fuel consumption, lb per s.h.p.h. per cent efficiency.	Basic data.
A	2,000	Direct D.R. gear	5,200/120	0·558 25 per cent	63	19·6	0·602 23·2 per cent	Air inlet temperature, 68 deg. Fah. (20 deg. Cent.)
B	2,800	Electric	5,350/120	0·605 23·1 per cent	84	11·3	0·511 27·7 per cent	
C	2×7,000	Two shafts, direct D.R. gear	3,750/110	0·571 27·7 per cent	55	7·85	0·514 27·2 per cent	Gas inlet temperature I stage, 1,112 deg. Fah. (600 deg. Cent.). II stage, 1,040 deg. Fah. (560 deg. Cent.)
D	4,620	Net output turbine direct D.R. gear	8,500/115	0·529 26·4 per cent	65	22·9	0·525 26·6 per cent	Heat exchanger surface, 5·5 sq ft per s.h.p.
E	11,300	Net output turbine direct D.R. gear	7,000/125	0·536 26 per cent	47	11·1	0·483 28·9 per cent	

A. Single compressor, single combustion chamber, single turbine, heat exchanger, D.R. gearing, reversible variable pitch propeller.
B. Two-stage intercooled compressor, single combustion chamber, single turbine, gear-driven d.c. generators, heat exchanger and ordinary type propeller.
C. Two-stage intercooled compressor, single combustion chamber, single turbine, heat exchanger, D.R. gearing, reversible variable pitch propeller.
D. Two-stage intercooled compressor, single combustion chamber, single turbine, heat exchanger, propulsion turbine with astern turbine, D.R. gearing and ordinary type propeller.
E. Three-stage intercooled compressor, two combustion chambers, two-stage expansion with reheat between the stages, heat exchanger, two propulsion turbines with incorporated astern turbines, D.R. gearing and ordinary type propeller.

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NOTICE TO READERS

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THE CASE FOR THE FLYING BOAT

THERE has in the past been good reason for regarding the aeroplane as being on the whole a more efficient transport craft than the seaplane, for even when the latter took the form of a flying boat, its shape, oddly enough, was less ship-shaped than that of the landplane. The drag being higher, it followed that for equal engine power the speed was less. In the passenger-carrying business the three essential objectives at which to aim are comfort, speed and safety, and the order in which these are placed is vital. There has lately been a tendency to rank increased speed as the more important, despite the enhanced danger when taking-off and landing, to say nothing of an undesired addition to the noise intensity throughout the flight. This choice represents, we think, an inaccurate reflection of public opinion, and one which several recent happenings are likely to make even less correct. If civil aviation is to be widely accepted as a current means of travel, safety and comfort will need to be studied much more closely than they have been in the past. The current criticism of the "Dakota" for flying at a laden weight of 28,000 lb, instead of the lower and safer limit of 25,200 lb is an illustration of this fact. In this particular case the difference of 2800 lb does, it is true, mean some fourteen passengers less and it is also true that with this loss of passengers there would not be very many left to pay the cost of the journey. This aircraft, however, is near the end of its service, and it will be replaced by something better.

We conclude in this issue an account given to the Institution of Mechanical Engineers by Mr. Harry Knowler, well known as the chief designer of Messrs. Saunders-Roe, of East Cowes, on "Recent Developments in Flying Boats." The reason why a flying boat hull is less streamlined than that of a landplane lies chiefly in the existence of the main step. This is, or has hitherto been, a necessary feature to facilitate take-off, though once in the air it is merely a nuisance. There is naturally suggested the adoption of a movable form of step which can be put in action when on the water and out of action when in the air; but as the step must needs come in what is a highly stressed part of the structure the design is difficult. Mr. Knowler speaks with hope of an attempt now being made to replace the step by a high-pressure air jet. Should that idea succeed, the hull could be almost completely streamlined, save only for having to carry the tail units high enough to avoid damage from water spray. Mr. Knowler, agreeing no doubt with the shoemakers' dictum that there is nothing like leather, claims that the future of long distance ocean travel lies with the large flying boat, which, in his view, has as good a percentage structure weight as its rival, with but little more drag, which may soon be improved out of existence, and a far lower cost for take-off and landing facilities. This last point is very important, for, with the rapidly rising flying speeds of recent years, airports have to be miles in length, whilst with ever-growing landing loads, the runways have to be made stronger and stronger. The flying boat, on the other hand, only needs a sheltered surface of water of moderate area and no great depth, merely calling for it to be kept clear of such flotsam as might damage the hull.

It is a matter of common experience that though journeys by flying boat in recent years may have been slow, they have certainly been safer and more comfortable than those by landplane. They are safer in that there is a much better chance of a successful forced landing, whilst the large hull required for adequate buoyancy affords passengers more space in which to move around. If less speedy in the past, it is possible that the difference will be a good deal less in the near future. The fairing of the step and the making of the floats retractable will help to reduce drag, whilst the possible use of jet propulsion should enable wings and engines to be mounted in the lower position customary in landplanes with a gain in general structural efficiency. It is a nice question whether long-distance passengers will in future prefer the landplane or the flying boat. If they put their preferences for speed, safety and comfort in that order of merit, the landplane will no doubt win. But if, as is not unlikely, they decide to reverse that order, the flying boat should recover the place it formerly held in the airline fleets of the world.

ELECTRICITY SUPPLY IN WARTIME

THE activities of the electricity supply industry during wartime are officially recounted in the twentieth report of the Electricity Commissioners, recently published. It covers the six years from April 1, 1939, to March 31, 1945—six years of applied ingenuity and unremitting zeal devoted to the maintenance of a service that was fundamental to the Allied war effort. That the industry succeeded in supplying electricity in increasing quantities wherever it was needed, in spite of shortages of material and of labour and in the face of repeated hostile air assaults, was a major achievement which went unheralded simply because the efficiency of electricity supply had come, before the war, to be taken so much for granted. That the industry now finds increasing difficulty in maintaining supplies of electricity should cause little surprise. For, as the Commissioners' report clearly points out, development of supply facilities during wartime was deliberately and rigidly limited by the Government to those works which were essential to the immediate war effort. It will be remembered that, as long ago as 1941, the C.E.B. impressed on the Government the seriousness of the position which was likely to result from a national shortage of generating plant in the immediate post-war era. At the time of this appeal the Government decided that it could not allow the war effort to be relaxed by granting the necessary priorities for peacetime development. Nevertheless, the Government recognised that (in the words of the Commissioners' report) "the Board could not be held responsible if they were unable as a consequence of wartime policy and restrictions to meet the whole of the demands upon the grid system in the period following the termination of hostilities."

To assess the magnitude of the task involved in electricity supply during the war years it is necessary to appreciate the far-reaching changes in the size and distribution of the demand which accompanied the rapid change-over from a peacetime economy to the complete harnessing of the national resources to the war effort. It is true that there were certain influences tending to limit the demand for electricity—black-out restrictions, Government controls which drastically curtailed normal electrical load development, and from 1942 onwards the intensive fuel economy campaign. These favourable factors were, however, soon outweighed by the rapidly growing demand for electricity to assist the vast production programme and to supply the needs (by no means negligible) of a large number of Service establishments. To complicate the supply problem it must be recognised that the increased demand for electricity was accompanied by marked changes in the geographical distribution of load centres. As large numbers of factories were established in the west of the country, so the centre of gravity of the electrical loads moved westwards. This transfer of industry, which was closely dependent upon corresponding transfers of electrical energy, could not have been quickly accomplished without the inherent flexibility of the grid system. The report points out how new transmission lines were erected to reinforce the existing grid so that it became possible to transfer very large blocks of power from areas such as the South-East, where the generating capacity exceeded the demand, to other areas such as the South-West, where the new industries created a load that could not have been supplied from local generating stations.

In a recent I.E.E paper, "The British Grid System in Wartime," by Hacking and Peattie, the authors state that a total of 363 miles of 132-kV transmission lines were erected to form these special wartime grid reinforcements and it is interesting to observe that 132-kV grid extensions, representing merely normal development, were limited, in the same period, to a length of 122 miles.

It is evident from the report that one of the most difficult wartime problems confronting the Electricity Commissioners was the provision of new generating plant. For a number of years before the war the growth in demand for electricity was continuous from year to year and to a large extent predictable. Under such conditions it was not very difficult to estimate the probable winter demand some three or four years ahead, so that the necessary programme of plant extension could be initiated in time to enable the plant to be ready for operation when it was required. For a number of reasons this orderly development was of necessity interrupted during the war. In the first place, there were a number of changes in the character and distribution of the load, which made it increasingly difficult to budget in advance for the provision of adequate generating plant capacity. Many of these changes—lighting restrictions, evacuation of populations and industries and shift working in factories—were abnormal and temporary, and resulted in somewhat fortuitous changes in load factor. For example, the load factor on the grid system rose from about 36 per cent in 1938 to about 50 per cent in 1942, and then fell within two years to 47·6 per cent. The principal obstacles in the way of a normal development programme for generating plant, however, were the restrictions designed to halt all production that did not contribute immediately and directly towards an increase in war potential. That nearly 3 million kW was added to the generating capacity of selected stations during the period under review was therefore a considerable achievement. This figure represented an increase of 36 per cent over the installed capacity at the end of 1938. During the same period, however, the total demand for electricity increased by no less than 56 per cent, so that, even when due allowance is made for the improved load factor, it becomes evident that the provision of new generating plant could not keep pace with the growth in load. Moreover, during the war extensive use was made of time-expired generating plant which, after twenty years' service, would normally have been scrapped. It was only when the end of the war was in sight that the Commissioners were given the opportunity of indicating to the Government the extent and scope of the work that was considered to be necessary to enable the electricity supply industry to meet its post-war obligations. It is significant that more than one-third of the total amount of generating plant for which provision was made during the war, was in fact sanctioned in the last twelve months under review. The development schemes that were then approved and put in hand cannot, however, mature before 1948 and 1949, and the cumulative leeway which is a direct legacy of essential wartime restriction can hardly be made good until 1950 at the earliest.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

FUEL AND THE FUTURE

SIR,—I have read Mr. G. F. Lake's remarks in your issue of Dec. 27, 1946, on the method of employing gases for power production, outlined in my letter of Dec. 13th. I may say that I am naturally aware of current developments in gas turbines and have been interested in progress made with them over the past twenty-five years. Further, my proposed method resembles the Escher-Wyss turbine, only in so far that both work on a closed cycle; and there, I think, the resemblance ends, as the latter works with a base pressure of 6 atmospheres compressing to 24 atmospheres with external heating to 1100 deg. Fah. before entering the turbine and uses air as the working fluid, whereas with my method any suitable gas is used with an internal or base pressure (at commencement of compression) somewhere near the critical pressure and temperature for the gas. This pressure is, for physical reasons, always necessarily on the high side.

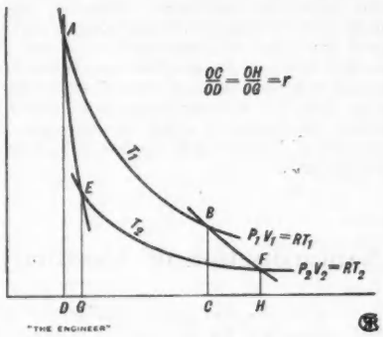


FIG. 1

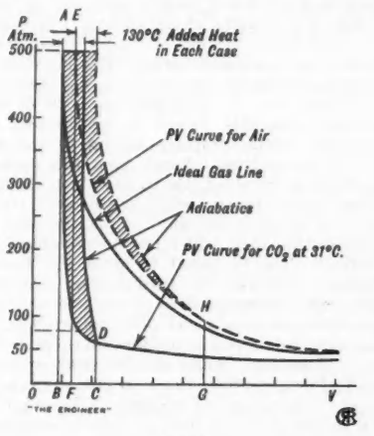


FIG. 2

An objection which might be made to the present-day gas turbine is that the negative work of compression absorbs such a large proportion of the positive work of the turbine. In addition, the upper temperature limit and compression ratio for real efficiency would need to be much higher than at present employed. Further, the machines as made to-day cannot for constructional reasons be "scaled down" in size so easily as they can be "scaled up"; this limits their utility and field of application.

Air as a working substance in heat engines functions, as is well known, as an almost perfect elastic fluid, *i.e.*, its deviations from Boyle's and Charles' laws are inappreciable and Carnot's ideal efficiency, $\eta = T_1 - T_2/T_1$, is applicable to air without sensible error. This is because air, as normally employed, is so far removed—in fact, by several hundred degrees—from its critical temperature that its "PV" curve plotted against pressures as abscissæ is practically a straight ascending line after a negligible dip below the horizontal "perfect gas" line at or around 75 atmospheres. The Carnot efficiency is the ratio of the difference between the work of an isothermal expansion (heat added) and the work of an isothermal compression at a lower temperature (heat rejected) of the same volume or pressure ratio to the work of the isothermal expansion, the two work curves being connected by adiabatics (Fig. 1).

$$\text{Work of compression} = P_2V_2 \log_e r \quad \text{(area EFHG)}$$

$$\text{Work of expansion} = P_1V_1 \log_e r \quad \text{(area ABCD)}$$

$$\text{Efficiency } \eta = \frac{P_1V_1 \log_e r - P_2V_2 \times \log_e r}{P_1V_1 \log_e r} = \frac{RT_1 \log_e r - RT_2 \times \log_e r}{RT_1 \log_e r} = T_1 - T_2/T_1.$$

The above assumes a constant value of PV or R, which is practically true for air under normal conditions. But with an imperfect gas not far removed from its critical temperature of 31 deg. Cent. such as CO_2, the values of PV at a given temperature, *e.g.*, 20 deg. Cent. or 50 deg. Cent., descend with increasing pressure to a low minimum at about the critical pressure and then increase again to nearly the original value at 500 atmospheres thus :—

P atmos.	PV 20 deg.	PV 50 deg.
1...	1·000	1·00
50...	0·680	0·92
75...	0·180	0·70
100...	0·228	0·49
200...	0·419	0·50
500...	0·938	1·02

From the foregoing it is evident that towards critical conditions the range of temperature worked through has to be considered along with different values of PV (or R) at different pressure and temperature levels. Fig. 2 shows how the negative work of compression using air and represented by the area $EFGH$ is several times larger than the area $ABCD$ under the PV curve for CO_2. For instance, if the value of PV at the critical is 0·22 at a pressure of 73 atmospheres and 1·00 at 500 atmospheres,

$$\text{efficiency} = \frac{1{\cdot}00 \times 434 - 0{\cdot}22 \times 304}{1{\cdot}00 \times 434}$$

$= 84{\cdot}4$ per cent approximately, assuming temperature range is 130 deg. with the compression isothermal at 31 deg. Cent. (304 deg. Cent. abs.). The mean effective pressure will be about 3500 to 4000 lb per square inch. With air the efficiency will be much less, as also will the m.e.p. I hope the above reasoning makes the thermodynamic behaviour of gases worked down to their critical conditions clear to Mr. Lake and other interested parties: it will be apparent that these conditions are also "critical" for highest *practical* thermal efficiencies, as distinct from mere academic statements of efficiency involving very large temperature ranges.

One of the chief advantages is in being able to utilise waste heat or low-grade heat and convert the greater part into work, so increasing

the overall efficiency of the plant with which it works in conjunction.

F. R. DIMBLEBY.

Ipswich, January 19th.

MECHANICAL ENGINEERING AND AGRICULTURE

SIR,—Might I add the following comments to those already made by Messrs. Broadfoot and Duckitt ?

Farmers are not engineers; few are even passable mechanics. Their interest is in producing crops, in cattle and in trying to keep clear of Nature's snares. This lack of mechanical interest has possibly had some bearing on the slow development of farm machinery; but it is difficult to see why the farmer has not demanded many simple improvements in implements in general use on all farms.

Modern plough and cultivator designs still permit free access of grit and water to wheel bearings and lifting mechanisms. Artificial fertiliser distributors are abominations; they cannot be cleaned unless fully dismantled, and the whole mechanism is usually locked solid when the machine has been laid aside for a short period. Many machine parts cannot be either greased or oiled due to absence of nipples or oil holes, and frequently in new machines the latter, when drilled, are filled with attractively coloured paint as applied to the bulk of the machine. The reciprocating cutter of the mower and binder cause much annoyance due to frequent breakage, and combined side rakes and swath turners can be relied upon to provide a crop of trouble every year. Credit is due to the agricultural machinery designer for his ingenuity, but the farmer is worthy of much better than ingenious gadgets; sound mechanical design should be incorporated in all farm implements.

Combined harvesters and grain driers complete farm electrification and special implements are matters of some importance; but let first consideration be given to improvements to basic implements in regular use by all farmers. Reliable implements will help counter the labour shortage, assist the farmer in his difficulties with Nature and increase the productivity of the land.

ALFRED COPELAND.

Winchester, January 29th.

Coast Erosion and Protection

ANSWERING questions in Parliament last week, the Prime Minister said that the Government had decided that the general responsibility for dealing with problems of coast protection should rest with the Secretary of State for Scotland and the Minister of Health. The Minister of Agriculture and Fisheries would, however, retain jurisdiction in regard to works on low-lying lands carried out by land drainage authorities in England and Wales. Legislation would be introduced, as soon as Parliamentary time permitted, to increase the powers and duties of county councils in regard to coast protection, to authorise the payment of annual Exchequer grants in aid of future loan charges falling on them in respect of protective works begun since the end of the war, and to require county councils to make suitable contributions towards the cost of schemes of county district councils. The Prime Minister added that pending legislation, the authority of Parliament was being sought for the payments of such grants out of voted moneys, and county councils would be expected to make appropriate contributions. It would be realised, he said, that in present conditions of labour and materials only works of the more pressing urgency could be undertaken.

Britain's Flying Boat Base

THE Parliamentary Secretary to the Ministry of Civil Aviation stated at the end of last week that the Government had considered the recommendations for a permanent flying boat base made by the Pakenham Committee. Langstone Harbour, Portsmouth, and Cliffe, near Gravesend, had been suggested as possible sites, the Committee expressing a preference for the former. The Government had concluded, however, that the balance of national advantage was against further consideration being given to Langstone Harbour, owing chiefly to the difficulties arising from its proximity to the main naval base of Portsmouth. In the light of this conclusion therefore it had been decided to proceed with a detailed examination of the Cliffe site from an operational and engineering standpoint in order to determine the physical and financial implications of its possible development.

Nationalisation of Electricity

IN a memorandum on the Electricity Bill, which came up for its second reading on Monday and Tuesday last, the London Chamber of Commerce has submitted its views to the Prime Minister, the Minister of Fuel and Power, and the President of the Board of Trade. It appeals to the Government not to expose industry and commerce at this critical time to the uncertainties and hazards which the passing of the Bill would involve. It points out that the objectives set out in the explanatory and financial memorandum of the Bill were already in the process of being realised without nationalisation. The introduction of a new and untried system must inevitably result, it says, for the time being, in confusion, uncertainty and misunderstandings. A nationalised concern, it goes on to say, will certainly employ a relatively larger administrative staff than a public company and with the present shortage of manpower it is clearly of paramount importance to avoid the diversion of labour from actual production to administration. Dealing with the specific provisions of the Bill, the Chamber considers that the proposed network of consultative councils would be performing the functions which properly belong to the area boards themselves. Apart from the wasteful duplication involved, the public, it is claimed, should have direct access to the area boards with its suggestions and complaints, and the interposition of a buffer has no possible justification. The proposal to give the Central Authority power to manufacture electrical plant and electrical fittings, and to sell, hire and otherwise supply such plant and fittings, and also to install, repair and maintain them, would, it is pointed out, enable the Government to use the full weight of the State to put a number of small concerns out of business. The argument for nationalisation that electricity supply is by its nature monopolistic, cannot, it is pointed out, be advanced in the case of such activities, which are to a large extent carried out by the small man. The Chamber believes that taking powers to deprive people of their livelihood without compensation, is quite indefensible, whether the businesses are large or small.

Literature

SHORT NOTICES

Mold's Ratios. Compiled by C. Mold, Shipley: J. Parkinson and Son. Price 10s. 6d. net.—The first edition of these tables was published in 1922 and, although primarily intended for simplifying the calculations required when cutting spiral gears in "Sunderland" gear planers, they are equally applicable to any case in which it is required to know correct gears for a given ratio. In this new edition all the ratios have been worked out to five places of decimals, and the tables show the gears for obtaining 5539 ratios from 0·40000 to 2·50000. Once the method of using the tables is understood, and a simple, concise description of this is given, much of the time usually needed in complicated gear calculation can be saved by the use of these ratios.

Cutting Tools for Engineers. By A. H. Sandy, A.M.I.P.E. London: Crosby Lockwood and Son, Ltd., 20, Tudor Street, E.C.4. Price 5s. net.—The correct selection and use of a cutting tool is the basis of efficient machining, and the object of this little book is to present in a clear and simple manner the principles and application of the various types of cutting tools in general use. It opens with some general chapters on the subject of machine tools, tool materials and the principle of cutting, followed by sections on the tools used on the various types of machines. Engineering students and apprentices will find this a very useful little manual to supplement the practical experience they acquire in the machine shop.

Saws and Sawing Machinery. By E. N Simons. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, W.C.2. Price 15s. net.—The importance of the saw in industry does not always receive the recognition it deserves, notwithstanding the fact that it is almost invariably the first tool to be used for a majority of operations. The final costs of many jobs can be considerably affected by the correct selection and use of saws and sawing machines. For this reason alone, this little book is well worth reading by all connected with industry who use saws as a primary tool or in the many secondary operations for which these tools are suited. The contents naturally fall into a number of sections on handsaws, circular saws for wood and metal, inserted tooth and segmental saws, circular friction discs, diamond-fitted stone and slate saws, hacksaws, and bandsaws. In each case the functions, method of manufacture, principles of use, and the machines on which the saws are used, are described in detail in a concise, easily understood manner. The written matter is well supplemented by drawings and illustrations, and useful general information and tables are given in an appendix. This book will be a useful addition to the library of any practical engineering executive or wood-working machinist.

BOOKS RECEIVED

The Petbow Welder's Guide. Watford: Petbow, Ltd., Station Estate, Barmoral Road, Watford. Price 6d.

Engineering Radiography. Manchester: Emmott and Co., Ltd., 31, King Street West, Manchester, 3. Price 2s. 6d.

Acoustics for Architects. By E. G. Richardson. London: Edward Arnold and Co., 41, Maddox Street, W.1. Price 5s.

Small Traders and the Law. By H. Ison Porter. London: Stevens and Sons, Ltd., 119, Chancery Lane, W.C.2. Price 4s. 6d.

Power Transmission Trade Names Index Directory. Sixth edition. London: Trade and Technical Press, 65, Chancery Lane, W.C.2. Price 5s.

Water Circulation in Steam Boilers. By J. Webster. Manchester: Emmott and Co., Ltd., 31, King Street West, Manchester, 3. Price 2s. 6d.

Aeroplane Performance Theory. By E. Davison. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 8s. 6d.

Applied Descriptive Geometry. Third edition. By Frank M. Warner. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 12s. 6d.

Where to Find Information on the German Chemical Industry. By L. Wilson Greene. U.S.A.: L. Wilson Greene, 54D, Oak Grove Drive, Baltimore, 20. Price 1 dollar.

Definition and Measurement of Gloss. By V. G. W. Harrison. London: Printing and Allied Trades Research Association, Charterhouse Chambers, Charterhouse Square, E.C.1. Price 10s.

Carbide-Tipped Turning Tool Life

THE INSTITUTION OF MECHANICAL ENGINEERS

AN extra general meeting was held at the Institution, London, on Friday, January 31, 1947.

The following paper, an abstract of which is reprinted on page 153, was read and discussed:—

"The Life of Carbide-Tipped Turning Tools," by F. F. P. Bisacre and G. H. Bisacre.

Discussion

Mr. C. Eatough said the paper described a novel approach to the question of carbide tool life, but he felt that the whole story of this most complex problem, as it affected the machine shop as distinct from the laboratory, was still far from being known. Undoubtedly the temperature conditions obtaining on the top face of a cutting tool had an important bearing on its behaviour in service, but whether the mathematical expression numbered (2) on page 7 of the paper was a true interpretation of the practical data was open to some doubt. Presumably the expression agreed with the recorded data to a fairly close approximation over the field covered by the conditions specified in Table I. Probably other expressions could be obtained which would give agreement as close as ± 13 per cent, but would involve other indices to the various factors entering into the expression, and possibly other factors as well.

An analysis of capstan and combination turret lathes manufactured in large quantities by four makers of international repute, two British and two American, showed that the steps between the various speeds and feeds on machines of comparable size were rather wide. Using any of the aforementioned modern machines on general production work, it would not be unreasonable to assume that speed and feed variations of as much as 25 per cent departure from the ideal would be fairly common.

In expression (2) on page 7 of the paper it was stated that the index of v was 6 and of t was 4. Those, taken together, were surprising figures if regard were had to the average machine shop, where great discrepancies in both speeds and feeds were used without very serious effect. If the cutting speed for a job was increased by, say, 25 per cent, and the feed was also increased by the same amount, other conditions remaining the same, then according to that expression the effect on tool life would be to reduce it in the ratio of 9 : 1. If speeds and feeds were so critical, it was amazing that in a production shop it was possible to get the tool life which was, in fact, obtained, unless it was that the normal operating conditions were very inefficient, which he was afraid that he could not accept. If speeds and feeds had to be held to really close tolerances, there would be a complete case for the introduction of machines with infinitely variable speed control, both to the spindle and to the feed drive mechanisms; but the necessity for such machines had not yet made itself felt.

In originating expression (2) on page 7, the authors had been careful to limit the range to that covered by the conditions in Table I. On the same page of the paper an extension was suggested, bringing in the length L of the cutting edge. There was more in this than was at first apparent. It had been stated clearly that the tool tip shape must be unaltered, and he took it that this was meant in the strict geometrical sense. If this was so, any alteration in length must be accompanied by corresponding alterations in the width, length and breadth of both tip and tool shank. One was here concerned with a volume change which was proportional to L^3.

He had taken the liberty of using variations in cutting speed and feed of the order of 25 per cent, and suggested that such variations were not likely to affect tool life under actual working conditions to the extent indicated by expression (2). Was he being unreasonable in using a step of 25 per cent in extending an expression which had been restricted to come within the scope of Table I? He could not answer that, but he would like to know whether the authors were entitled to extend the same expression in the manner shown in the examples on the following page, where the length L had been decreased from the 1in used in the original experimental work to $\frac{3}{4}$in. This resulted in a tool having a volume of only half that of the original test tools, a variation of 100 per cent. That must have a tremendous effect on the heat flow conditions from the cutting edge.

He must accept the fact that the result of the 1942 test, detailed in the paper, agreed very closely with the authors' expression, but he would like an assurance that the multiplicity of other conditions obtaining with the tests of Judkins and Uecker nearly ten years before was strictly complied with in the 1942 experiment. It was stated that forgings of a Brinell hardness of about 220 were used in the 1942 tests, but, as the recent Conference on Machinability had shown, this factor alone was not a true indication of the machinability of the material or of the rate of tool wear.

Continuous and Intermittent Cutting by Tools

The paper dealt with turning tools only, but, as this was closely allied to milling in some respects, he hoped that he would not be accused of complicating the issue if he mentioned a point which appeared to affect both types of machining. In the average machine shop continuous turning of long lengths was the exception rather than the rule, as most production work was relatively short and the cutting was intermittent on that account. That had two important effects. First, the tool had time for the heat of cutting to diffuse between cuts, and, secondly, it had repeatedly to be plunged into fresh metal at the start of each run. Possibly the time element, which permitted cooling, extended the useful tool life far beyond that which might be expected from tests on long continuous cuts; on the other hand, the necessity for starting fresh cuts undoubtedly had a detrimental effect on tool life.

He had for some time been recording the peripheral footage run by carbide tools on certain jobs, both face milling and turning. He found that turning tools would run for about twice the distance of the individual blade cutters making up a face cutter. He realised that any direct comparison between turning and milling must be open to question, but undoubtedly the greatest difference between the two processes was the relatively continuous nature of the cutting of one and the intermittent nature of the other. If, as appeared to be the case, the process of entering fresh metal and originating stable chip flow conditions had a bearing on tool life, it would be necessary to add another factor to the already formidable list in Table II. Such a factor would be of importance for quick-cycle production turning work, and might possibly assist in the application of similar analyses to the milling processes.

Mr. W. F. Cope said that he was interested in dimensional analysis and heat transfer, and it was from that side of the subject that he was venturing to intervene in the discussion. He thought that if any prize was being offered for the largest number of dimensionless groups, the authors should win it easily, for they had the biggest number that he had ever encountered. Mr. Cope then proceeded to deal in some detail with the groups of dimensionless numbers given by the authors.

Mr. A. W. J. Chisholm congratulated the authors on a very constructive paper, which advanced the thought on the subject with which it dealt tremendously. Merchant realised the importance of temperature, but avoided dealing with it as far too difficult; and, of course, it had been obvious for a long time that temperature was *the* factor, or one of the main factors, in varying conditions in machining.

There were a few points in the paper on which he would like to comment. Under the heading "The Physics of Chip Production" mention was made of the "Taylor crack," and in a footnote the authors quoted Rosenhain's and Sturney's photographs as showing it clearly. The "Taylor crack" was the crack running ahead of the tool. As far as he knew, Rosenhain's theory showed definitely that there was no crack running ahead of the tool.

There was, however, a very slight indication that the chip came off with a built-up edge. In that case fracture of the material at the work surface occurred behind the built-up edge. The authors, he thought, were trying to suggest that there was a crack higher up, but that was not the case. In the photograph of the recrystallisation microsection there was a very slight indication of a short crack, but it did not precede the cutting point.

Reference was made to the fact that the cutting force was supposed to fall off slightly as the speed rose. He did not know what the word "slightly" was intended to infer, but experiments by Professor Arnold and others by himself showed that from zero to 300ft per minute the force could actually drop off by as much as 20 to 40 per cent when cutting mild steel and also in some experiments with bronze.

Distortion of Work Surface

There was one comment which he would like to make on Fig. 5. During the last nine months they had been carrying out experiments to investigate the distortion of the surface material of turned surfaces and also the distortion and the character of the distortion in the chip for a wide variation in rake angle and cutting speed. Unfortunately, he had not yet obtained the results of the distortion of the chip, but there seemed to be an element of doubt about the argument that because in Fig. 5 there was extra distortion at the chip tool interface, of a different character from the rest of the chip, the temperature there was necessarily higher than in the rest of the chip, and the gradient went from there down to the top side of the chip, on the outer edge of the chip. The experiments which they had been doing showed that there was a terrific variation in the

type and character of the distortion of the work surface.

He thought that there was some analogy between the work surface and the chip surface, and that the argument put forward in the paper was perhaps an over-simplification. He was not sure of this, and he then put forward some suggestions.

Dr. F. Rogers dealt briefly with some experiments he carried out in 1916 in connection with the temperatures of turning tools. He pointed out that the red-hot spot on a tool at work was to be found at the bottom of the tool and not on the cutting edge.

Mr. F. F. P. Bisacre, in the course of a preliminary reply, said that Dr. Rogers had given some very interesting facts about the temperature conditions at the tip of the tool. The truth was that the actual distribution of temperature in that tool tip was one of the problems on which the authors would like more information, and if anybody had the information they would be very glad to have it. It was one of the most difficult points, and it was true that, as had been suggested in the discussion, Dr. Merchant kept clear of it. Dr. Merchant knew that it was one of the most difficult points of all, and he had at present managed to get his results without it, though knowing that the question of temperature distribution lurked behind the whole problem.

Mr. G. H. Bisacre, who also replied, referred to the point raised by Mr. Eatough about the steps of speed and feed in capstan operation, and said that it was true that there would be a heavy fall in tool life with a step of the order of 25 per cent, and that with a drop below that speed one would be all right. He thought that that was the condition under which most working was done, and the idea of a close tolerance below which one must not run and above which one must not run did not seem to fit the facts.

Mr. Cope referred to the slinging about of dimensionless quantities with no analytical backing at all. That was largely what had been done, but in one case, the conduction of heat from the shear plane into the chip and into the work, the problem had been studied analytically as well, though it was not fully soluble analytically. Inevitably it was necessary to make certain assumptions, but whatever assumptions were made, the answer would be numerically different from practice, but of the form of a function of vt/h^2. That was being investigated experimentally in the Manchester College of Technology.

Mr. Chisholm and Dr. Rogers had raised the question of where was the hottest region in the whole combination. It had ranged, apparently, from a little below the surface in the chip to the extreme bottom of the tool, according to the views of different people. It was not a point on which the authors were prepared to commit themselves; it could only be solved experimentally. The various temperature readings taken by Herbert and by Kurrein did not entirely cover the range and there was again difficulty in interpreting them. It did not seem on the face of it, however, that the dimensional approach depended essentially on deciding and proving at the start where that hot spot occurred.

It was obvious that there were more variables to come, and as more information was obtained the range of quantities would presumably be increased rather than decreased, and that applied in particular to the study of the real nature of friction. The insertion of further variables, however, did not seem to be likely to invalidate what had already been stated about the variables which were known to exist and which were known to be relevant.

London Airport*

Introduction

WE were appointed to consider and make recommendations as to the best lay-out for an international civil airport for London within a defined area which is shown on the plan (Fig. 1) and making maximum use of the three runways already under construction. We were further instructed to plan the lay-out in such a way as to achieve the maximum traffic capacity. We were to bear in mind the many difficulties that were likely to result from any proposal to vary substantially the area of land which H.M. Government intended to take powers to acquire, particularly if the Perry Oaks sludge disposal works were affected. Minor variations in the proposed land boundaries could, however, be considered if they resulted in an improved lay-out. We were not required to give other than broad consideration to engineering aspects of the scheme, as these were the responsibility of the Director-General of Works, Air Ministry, who was represented on the Panel.

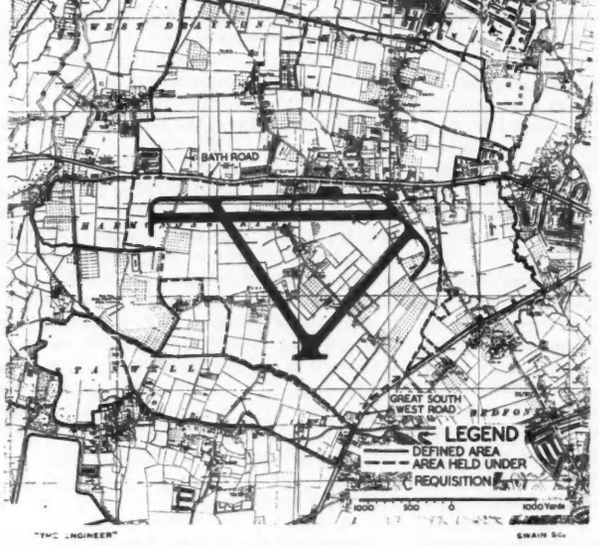


FIG. 1—DEFINED AREA AND RUNWAYS OF LONDON AIRPORT

Conditions Governing Lay-Out

In addition to our general instructions, the following conditions affected, in varying degree, the development of the site:—

(*a*) The airport must be developed in stages and the construction of each stage should interfere as little as possible with its use. As the airport had to be brought into use at an early date, it was essential that the three runways already under construction should be completed as originally planned. These three runways and temporary terminal buildings (Fig. 1) therefore constitute Stage I of the development. In Stage II we were required to plan for maximum air traffic capacity south of the Bath Road, in view of the need to postpone for a number of years both the diversion of that road and the demolition of housing north of it. In Stage III full use could be made of the site.

(*b*) An adequate area must be provided for aircraft loading and terminal buildings, commensurate with the capacity of the runway system and conveniently located in relation to that system and to surface access.

(*c*) Areas of sufficient size for aircraft maintenance, readily accessible to the terminal area and to public roads, must be allocated within the site in each stage of development.

(*d*) The lay-out must be suitable for use by the largest aircraft which could reasonably be foreseen. At the same time, we were to allow for extending and widening the runways wherever possible.

(*e*) We were to avoid, as far as possible, demolition of any ancient monument or building of historic interest, and we were to keep demolitions in general to the minimum consistent with obtaining an efficient airport.

Final Plan

The plan we finally recommend is shown in Fig. 2. It provides three parallel runways in each of three directions, the runways in the east-west directions being the main runways. The three directions correspond to those of the R.A.F. runways, this being necessary in order to incorporate them in the scheme, all three being used in Stage I. The R.A.F. runway in the north-west-south-east direction is replaced by a new runway in Stages II and III, although parts of it are retained as aprons and taxiways. If this were not done the terminal area would be too small. We examined the possibility of building the new north-west-south-east runways at a different angle from the R.A.F. runway, but concluded that the resulting slight advantage was outweighed by the disadvantages.

We had previously analysed the meteorological data and found that the most frequent winds were to be expected in the sector from south-west to west. On this consideration alone there was a choice between south-west and west as the main direction, and we finally chose west on account of other site conditions. The usability for the three directions adopted, based on a maximum permissible cross wind component of 12 m.p.h., is about 99 per cent. Consequently we considered that the gain in usability to be obtained from adding runways in a fourth direction was too small to justify the cost and complication.

No. 5 runway is the main primary runway and Nos. 1 and 8 are the main secondaries. As those secondaries have to be staggered, part of No. 1 runway, which has already been completed, will not normally be used, but its full length will be valuable as an alternative primary should No. 5 runway be out of use or in other emergencies. We considered the possibility of making No. 1 runway a primary, but all lay-outs incorporating this feature had disadvantages which were unacceptable.

The strip and runway lengths are as follows:

Runway No.	Description.	Runway length in feet.	Strip length in feet.
5	E-W main primary	9,500	10,500
1	E-W main secondary	11,570	14,570
8	E-W main secondary	6,600	9,000
2	NE-SW subsidiary primary	9,200	9,200
7	NE-SW subsidiary secondary	6,240	7,440
9	NE-SW subsidiary secondary	5,300	6,500
6	NW-SE subsidiary primary	9,200	9,200
4	NW-SE subsidiary secondary	5,840	6,150
10	NW-SE subsidiary secondary	5,300	6,500

The length of No. 5 runway can be extended to 10,500ft, should experience show that this is required. We considered that it was unnecessary to do this immediately because No. 1

* Report of Advisory Layout Panel. Extracts.

runway is the main primary runway during Stages I and II.

The approach clearance slopes start from the ends of the strips and the inner ends of the staggered secondaries have the prescribed clearances to allow for abnormal use in either direction.

The separation of the parallel runways used for simultaneous landings in normal operation is as follows :—

Direction of landing.	Separation in feet.
West-east	4645
East-west	7145
South-west-north-east	4650
North-east-south-west	7150
South-east-north-west	4400
North-west-south-east	6900

While these separations do not all achieve the 6000ft at which we aimed, those for landing in the east-west and north-east-south-west directions, which are the directions most frequently used, exceed this figure. The separation of staggered secondaries has been kept at 2500ft in all directions.

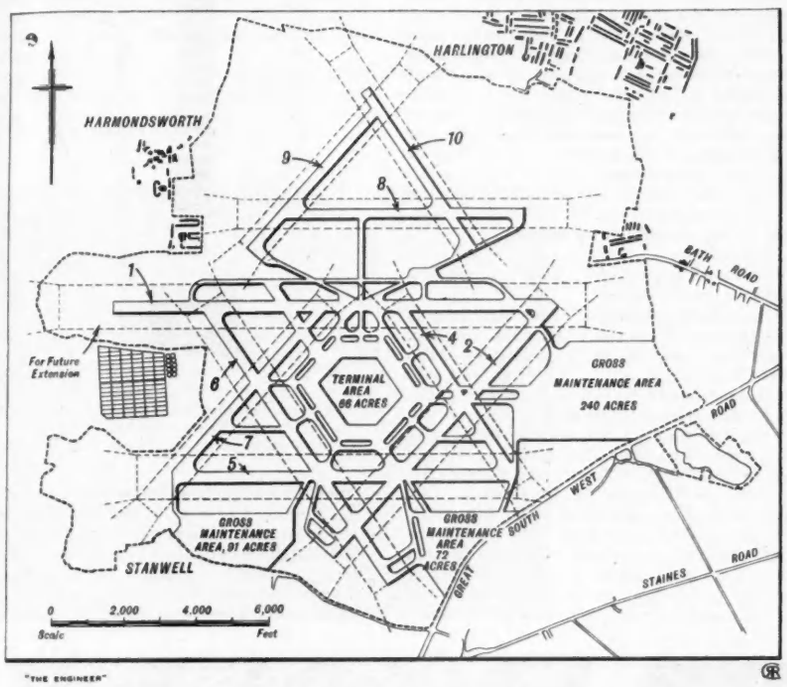


FIG. 2—RECOMMENDED FINAL ARRANGEMENT OF RUNWAYS

The terminal area within the building line comprises 66 acres and there are 6450ft of building frontage available. We did not feel called upon to recommend an alignment for the road tunnel giving access to the area as this will largely be determined by factors outside our terms of reference.

Three areas totalling about 400 acres, all south of the Bath Road, are available for development for aircraft maintenance, parking and ancillary purposes. Taxiways connecting these areas to the terminal area offer alternative routes and, although some runways must be crossed, the routes for any given wind direction will cause little interference with the runways in use.

The following three adjustments of the boundary were found necessary :—

(*a*) An encroachment of about 38 acres on the Perry Oaks sludge disposal works ;

(*b*) A diversion of the road connecting Stanwell and East Bedfont ;

(*c*) A slight realignment of the proposed Bath Road diversion.

When the runways in Stage III are constructed north of the Bath Road the village of Sipson will be demolished, but a large part of Harlington will remain. It has been possible to site all approaches so that little demolition will be necessary outside the boundaries of the airport.

While the lay-out of the three runways north of the Bath Road has been based on present knowledge, some modification may be desirable as a result of experience of the operation of parallel runways and improvement in equipment and technique by the time the construction of the runways is due to start. We recommend, therefore, that the boundaries north of the Bath Road as given to us should not be curtailed, the runways in Stage III being an integral part of the whole scheme of development.

Stages of Development

Stage I of the development consists of the three R.A.F. runways at present under construction, together with the taxiway parallel to No. 1 runway and temporary buildings between that taxiway and the Bath Road. Seventy acres of aircraft maintenance area are available in this stage.

Stage II provides a dual parallel runway system south of the Bath Road. Before the completion of this stage the north-west-south-east R.A.F. runway will have been replaced. A large part of the central apron will have been completed together with such portions of the permanent terminal buildings needed to meet requirements at this stage. The underground access to the terminal area will also have been constructed. All the areas allocated for aircraft maintenance, parking and other purposes will be available for development.

We are informed that the programme of construction from Stage I to Stage II can be so arranged as to permit continuous use and progressive increase of capacity of the airport.

Stage III consists in extending No. 1 runway westwards, constructing Nos. 8, 9 and 10 runways north of the Bath Road, together with their connecting taxiways, and increasing as necessary the facilities in the terminal area. The main portion of the runway and taxiway construction being north of the Bath Road, the use of the airport as existing in Stage II will be little affected.

We are informed that it is hoped to have Stage I in operation in 1946, Stage II in 1949 and Stage III in 1953.

Estimated Traffic Capacity

On the basis of an equal number of landings and take-offs and of the capacity of a single runway, which we adopted for planning purposes, we estimate that the maximum capacity of the airport during each stage in fair weather will be :—

	Aircraft movements per hour.
Stage I	40 rising to 50
Stage II	90 rising to 100
Stage III	160 or more

Owing to the many uncertain factors it is difficult to arrive at a similar assessment of capacity in bad weather, but for conditions of visibility less than 1000 yards or cloud base under 500ft we think that the proportion of bad weather capacity to good weather capacity might turn out to be :—

Stage I	One-third
Stage II	One-half
Stage III	Two-thirds

Assuming an average in Stage I of twenty passengers per aircraft, increasing during Stages II and III to twenty-five, the maximum number of passengers passing through the airport in an hour, based on the foregoing capacities, might be :—

Stage I	1000
Stage II	2500
Stage III	4000 or more

The Life of Carbide-Tipped Turning Tools*

By F. F. P. BISACRE, O.B.E., M.A., B.Sc.†, and G. H. BISACRE, M.A.‡

Adiabatic Theory of High-Speed Metal Cutting

The dearth of published data of a quantitative character on the life of carbide-tipped turning tools[1] is evident after a study of two of the most recent publications on the machining of metal. These are (1) the report of the Sub-Committee on Carbide Tools, published by the Institution of Mechanical Engineers[2] as part of the programme of work undertaken by the Cutting Tools Research Committee, and (2) the publication entitled "The Machining of Metals," by Hans Ernst and others, published by the American Society of Metals.[3] The first deals specially with tungsten carbide as the cutting medium and summarises two fairly recent sets of tests on tool life—(*a*) the tests by T. G. Digges[4] and (*b*) the Judkins and Uecker tests.[5]

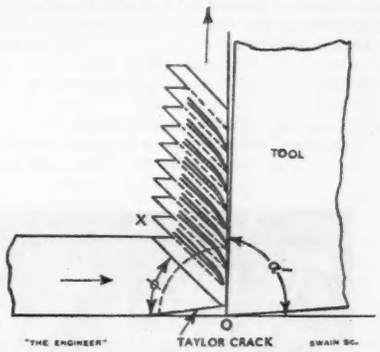


FIG. 1—*Thime's View of Chip Formation*

The work entitled "The Machining of Metals"

* Institution of Mechanical Engineers, January 31, 1947. Abstracted.

† Chairman, Blackie and Son, Ltd., publishers, London and Glasgow.

‡ College of Technology, Manchester.

[1] Since this paper was written several valuable papers have been published, notably (1) I. Mech. E., Conference on Machinability, "Machinability," 1946 ; (2) Ernst, H., and Merchant, M. E., 1941, "Chip Formation, Friction and Finish," (Cincinnati Milling Machine Co.) ; and (3) Merchant, M. E., 1945, *Journal Applied Physics*, Vol 16, pages 267 and 318.

[2] "Proceedings," I. Mech. E., 1938. Vol 139, page 3, Cutting Tools Research Committee, Report of the Sub-Committee on Carbide Tools.

[3] Am. Soc. Metals, 1938, "The Machining of Metals," by Hans Ernst and others (Cleveland, Ohio).

[4] Digges, T. G., 1930, "Trans.", A.S.M.E., Vol. 52, Part 2, MSP–52–13, "Cutting Tests with Cemented Tungsten-Carbide Lathe Tools."

[5] Judkins, M. F., and Uecker, W. E., 1933, *American Machinist*, Vol. 77, pages 325, 364, "Cemented Carbide Cutting Tools."

is a series of four lectures delivered at the twentieth National Metal Congress, Detroit, in October, 1938. The first lecture deals with the physics of metal cutting, and the three following lectures with the machinability of different materials, including steel.

Both publications report the lack of quantitative information. In the first we read :—

"There appears to have been no study of the most economical life of cemented carbide tools ; that is, a study of the cost of the use of these tools in relation to the saving in the cost of machining, as compared with high-speed steel tools under various conditions. A member of the Committee has put this in another way. He states that 'the Committee should find out

Cutting speed, 50 ft per min. ; width of chip, 0·35 inch ; thickness, 0·1 inch.

FIG. 2—"*Block*" *Type of Chip*

the performance of carbide tools when cutting standard and commonly used materials in such a way that, on the basis of a standard tool life, a series of curves can be produced for various depths of cut. 'When a series of curves is available it would be possible to calculate the performance of a carbide tool, which when taken in relation to the cost of the tool would show quite definitely what saving is to be obtained by the use of carbide tools.' This would mean the establishment of a cutting speed-tool life relation."

In the second, Hans Ernst writes :—

"The story 'What happens in metal cutting' is approaching completion, but it is still only a story. We can now form a better mental picture of chip formation under various conditions, and visualise the effect of certain metallurgical and machine operating factors, but our knowledge so far is qualitative rather than quantitative."

This lack of quantitative information must have been felt by everyone engaged on large-scale mass machining during the war.

In the following pages certain lines are suggested which may possibly lead ultimately to a rational quantitative theory of tool life. Such a theory must be, in essence, a quantitative presentation of the qualitative facts of the physics of chip production. Once the dominant physical quantities are identified, the well-known method of dimensions should be a help—as it has been in the kindred, but far less complex, problem of the resistance to flow of fluids in pipes.

Tungsten Carbide.—Tungsten carbide hard alloys owe their existence to the discovery of the manner in which an auxiliary metal, usually cobalt, can be introduced in order to give the necessary toughness to the final product ; together with another auxiliary metal to increase resistance to abrasion. Tantalum is sometimes added (it forms a carbide) to increase the resistance to abrasion, or titanium is introduced for much the same purpose.

The material is excessively hard (1400 Brinell is claimed as against 800 Brinell for 18 per cent tungsten high-speed steel) and—this is the essential point—it substantially holds its hardness up to about 800 deg. Cent. (1470 deg. Fah.), whereas high-speed steel fails at about 600 deg. Cent. (about 1110 deg. Fah.). This fact permits the cutting edge in dry turning to run at higher temperatures than with high-speed steel, and hence higher speeds of cutting can be used. But this special feature of tungsten carbide is further enhanced by the fact that it has a thermal conductivity about four times that of steel. Its exceptionally high thermal conductivity aids materially the cooling of the edge. The material is, in a sense, "self-cooling" to a much greater degree than high-speed steel.

The penalties paid for these substantial advantages are these :—

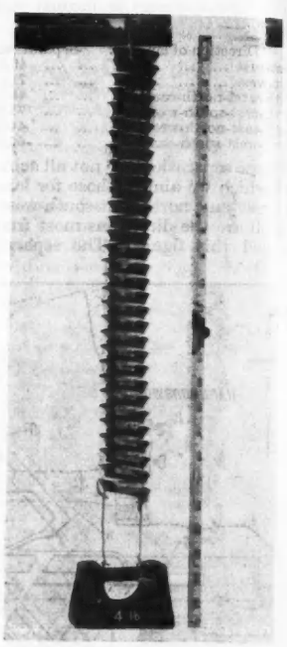
(1) It is very expensive. The high cost is due to the costly process of manufacture, &c. It has little relation to the actual value of the tungsten in it.

(2) It is excessively brittle. Cobalt is the usual metal alloyed to give it toughness, which, of course, it does at a sacrifice of hardness. For instance, with 3 per cent of cobalt, the hardness is said to be 1380 Brinell, and with 20 per cent of cobalt the hardness is lowered to 755. Impact numbers do not seem to be known for the material. The brittleness makes it intolerant of the slightest chattering of the tool (which, in its turn, means exceptionally heavy lathes and tool-boxes), and of anything in the nature of surface scratches (which again means precision grinding and lapping)—all the more difficult on account of the extreme hardness which demands special abrasives. It also brings about a high proportion of "erratic" failures.

(3) It is possibly more extravagant in tungsten than high-speed steel, because of the high proportion of erratic failures.

These penalties are so serious, it is stated in the Institution's report of the Sub-Committee on Carbide Tools, that "some users, while adopting tungsten carbide tools for machining cast iron and malleable iron, have had no success with such tools on steel. Professor Boston maintains that tungsten carbide has not proved itself superior to high-speed steel when cutting mild or soft steel with a hardness number below 220 Brinell."

Be this as it may, it was used all over the country during the war of 1939–45 for machine



Cutting speed, 285 ft per min. ; width of chip, 0·5 inch ; thickness, 0·035 inch.

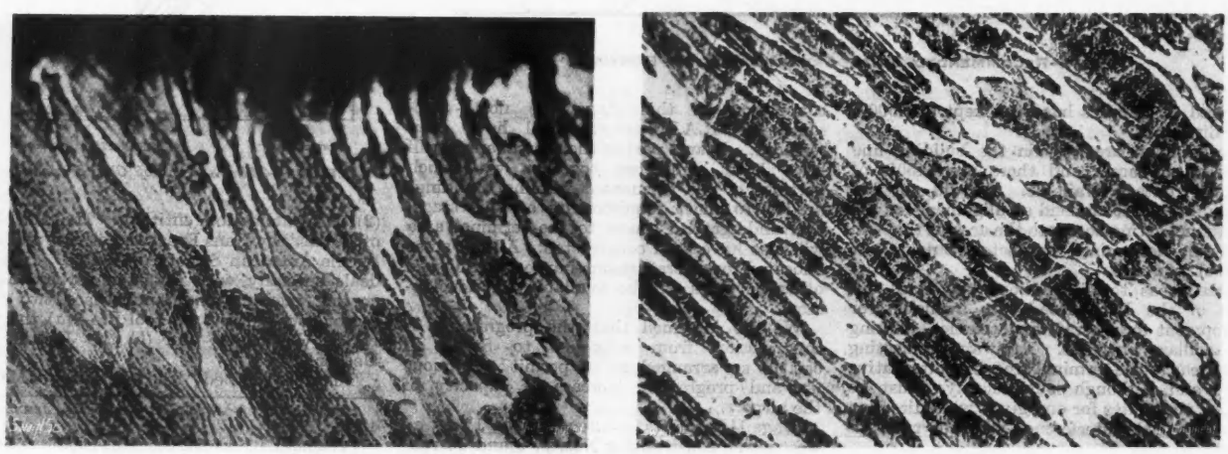
FIG. 3—"*Ribbon*" *Type of Chip*

ing medium-carbon steel in mass-production jobs.

The Physics of Chip Production.—The input of energy from the main motor goes principally as heat energy into :—(*a*) The chip cut. (*b*) The billet by "back" conduction ; and, (*c*) The tool-box by conduction through the tool shank.

Clearly an upper limit to the average temperature rise of the chip is got if it is assumed that the whole of the energy input goes into the chip.

This upper limiting average temperature can be readily found. For instance, for a 0·4 per cent carbon steel, a chip $\frac{1}{8}$in$\times\frac{1}{100}$in at 300ft per minute requires some 15 h.p., giving an average rise of temperature of about 600 deg. Cent. (about 1110 deg. Fah.), *i.e.*, an upper limiting average temperature of about 617 deg. Cent. (1143 deg. Fah.) at a room temperature of 17 deg. Cent. (62·6 deg. Fah.). This figure is reduced by the loss of heat to the billet, by



(a) (b)

FIGS. 4 (a) AND (b)—*Photomicrographs of Longitudinal Section of Ribbon Chip* (×500 diam.)

"back" conduction and to the tool-box, *viâ* the tool, so that it may fall to some 517 deg. Cent. (say, 945 deg. Fah.). But the question arises, Is the temperature uniformly distributed through the chip thickness? The authors think that it is not; it will be higher (perhaps much higher) in the bottom of the chip in contact with the tool face, and lower on the top surface of the chip, for reasons that will now be discussed.

Fig. 1 illustrates the general theory of chip formation first put forward by Thime in 1878, and subsequently confirmed by Ernst, Schwerd and others.

Ernst has classified chips into three types:—(1) A "block" chip in which total or partial rupture takes place; (2) a "ductile ribbon" chip in which the metal is subjected to a pure plastic flow, without fracture; and (3) the same formation as type (2) but complicated by the existence of a "built-up" edge. Within the range of speeds and feeds considered in this paper, a medium-carbon steel gives a characteristic type (2) chip when working with dry tungsten carbide.

A quantitative theory of the forces involved in type (2) cutting has been given by Ernst and Merchant, which is essentially a mechanical theory. The authors believe that, as the physical constants used in it are themselves functions of the local temperature, the connection between speed and forces—and hence wear (*i.e.*, life)—must involve the thermal as well as the mechanical properties of the tool and "less work."

FIG. 4 (c)—*Photomicrograph of Longitudinal Section of Ribbon Chip* (× 500)

Fig. 2 shows the first type of chip and Fig. 3 the second. The chips shown in these illustrations were both cut from medium carbon steel with dry carbide tools of exactly the same design and tool angles. The "block" type was cut at a slow speed (about 50ft per minute) whereas the chip shown in Fig. 3 was cut at a far higher speed (about 285ft per minute). It is the normal type of chip cut with no chip breaker in use. The dimensions of this chip as cut are ¼in × 0·035in. It is, the authors find, typical of high-speed turning of medium carbon steel with dry tungsten carbide tools. Figs. 2 and 3 show that the two sorts of chip can be produced from the same material with the same tool, provided suitable conditions exist.

The type of chip determines the manner in which the tool finally fails. In the block type the cutting edge is continuously penetrating fresh metal so that the tool fails by mere blunting (rounding) of the edge. On the other hand, with the ribbon type the edge of the tool is said to be preceded by a tiny crack that runs in front of it—the "Taylor crack."[6] It would save the edge of the tool from immediate destruction. The load falls on the tool face just behind the edge, and abrasion takes place whereby a small cavity is formed. When this cavity gets sufficiently deep, the tool edge lip breaks off, with the destruction of the tool.[7]

Friction.—Friction plays a major part in the geometry of the formation of a type (2) chip. Under the conditions of very clean contact which exist in a cut, the coefficient of friction is very large, of the order 0·5 to 1·0. It is difficult to see how the frictional surface stress in the limit can exceed the ultimate shear stress of the material, regardless of the normal pressure. This is borne out by tests made with steel punches in hardened copper. These tests revealed a frictional surface stress of 17 tons per square inch, which is about the ultimate shear stress for the copper used.[8]

Formation of Heat.—Heat is formed in the chip in three distinct regions—the shear plane OX (Fig. 1), where the main plastic flow takes place; the actual tool face where ordinary surface friction takes place; and the "boundary layer" of the chip at the tool face, where great plastic work goes on. These three sources of heat, together with a small amount lost in recrystallisation of the metal, must together equal the total energy input. This heat will be formed where the conversion of energy from the mechanical form takes place, and it is subsequently diffused by conduction through the body of the chip.

Temperature Distribution Through the Chip.—So far as average temperatures of the chip go it is obvious that they would be a maximum if all the mechanical energy put in by the lathe motor were carried away as heat in the chip, none being by-passed by the tool or lost by passing into the billet or in radiation.

This upper limiting value of the average temperature is quite unaffected by speed of cutting unless the main cutting force on the tool depends on speed—for both the horsepower and the quantity of metal cut are proportional to speed. Actually the force on the tool is supposed to fall off slightly as the speed rises, so that the upper limiting value of the mean temperature should be a little lower at high speeds.

But there may be temperatures far higher than the average in the lower layers of the chip and correspondingly lower ones in the outer layers.

A series of photographs of the structure of the ribbon chip shown in Fig. 3 shows the structure of the billet steel. It consists of (white) ferrite and (black and white) pearlite. Its percentage composition is—Carbon, 0·415; silicon, 0·18; sulphur, 0·028; phosphorus, 0·022; and manganese, 0·73. Its ductility is about 20 per cent. The photomicrographs in Fig. 4 have been made in the position indicated in Fig. 5. The photograph (*a*) is at the upper surface of the chip, (*b*) in the middle, and (*c*) at the lower surface of the chip which was in contact with the tool. They show that intense plastic flow has taken place, whereby the crystals have been slewed to an inclination of about 45 deg. to the direction of motion of the chip. The plastic flow (or, rather, drag) is obviously most intense in the lower layers in contact with or close to the tool face, a layer about 0·001in thick. These lower layers will therefore be the seat of intense heat generation arising from internal shearing and surface friction. Fig. 4 (*a*) shows how the parallel lines on the rough upper surface may have been formed. The brittle pearlite has clearly broken away, leaving the soft and ductile ferrite crystals projecting as fine needles. The scale of the photographs shows that these jags are about 0·001in deep, with a pitch of about the same amount, so it is a purely superficial effect.[9] There is no sign of any actual fracture along the 45 deg. lines of crystal displacement—a fact shown by the strength of the chip as a "spring" (Fig. 3).

The photographs show that the gradient of the distortion is more or less uniform (45 deg.) for about 95 per cent of the thickness of the chip (measured from the top surface) and then falls very rapidly to much lower values in the bottom layers—the layers adjacent to the tool, where plastic deformation has been severe.

There are two extreme cases under which plastic deformation can take place:—

(1) Adiabatically, when the heat developed stays where it is generated and does its worst in creating high localised temperatures. (There is no effective conduction from point to point until after a piece of the chip has passed the contact area—and then it does not matter!)

(2) Isothermally, when there is approximate uniformity of temperature throughout the billet and chip—this uniformity being attained by conduction. These two extreme cases are the high-speed case and the low-speed case. The actual temperature conditions under which the deformation takes place are thus very different and bring in their train the great differences in chip formation in the two cases.

One is thus forced to take account of—

(*a*) The time taken for the chip to cross the contact area (called the "transit time"), and

(*b*) The time temperatures take to adjust themselves in the chip by temperature diffusion.

If the length of the contact area is taken to be proportional to the chip thickness t, then the time of transit τ_1 is obviously proportional to t/v, v being the speed of cutting.

In discussing the time temperatures take to diffuse, physicists use a constant called "the relaxation time."[10] It is proportional to the square of the thickness of the slab in which conduction is taking place and inversely proportional to the thermal diffusivity h^2 (the conductivity divided by the product of the density and specific heat),[11] *i.e.*,

$$\tau_2 = \lambda \frac{t^2}{h^2}, \text{ where } \lambda \text{ is dimensionless.}$$

The constant or proportionality λ depends on the exact thermal problem in question. It does not depend upon the speed. There are thus for direct comparison, two "times"—the transit time and the relaxation time—and the ratio of the second of these to the first is a dimensionless number and proportional to vt/h^2. One is thus

[6] Ernst's photographs show very little evidence of the crack, but Rosenhain and Sturney's photographs show it clearly. See *Engineering*, 1925, Vol. 119, page 152, Report on Flow and Rupture of Metals during Cutting.

[7] Many researches have been carried out on chip formation. Taylor was the first to observe the crack running in front of the cutting edge in ribbon type turning ("Trans.," A.S.M.E., 1907, Vol. 28, page 31, "On the Art of Cutting Metals"). Kurrein investigated the microstructure of the two types in 1905. Other work has been recorded by Herbert ("Proc.," I. Mech. E., 1928, page 775; Cutting Tools Research Committee, Report on Machinability); Rosenhain and Sturney, *Engineering*, 1925, Vol. 119, page 151, "Flow and Rupture of Metals during Cutting"; and in the "Proceedings" of the Manchester Association of Engineers, 1911, and the Lathe Tools Research Committee, 1922.

[8] Bishop, Hill and Mott, 1945, "Proc.," Phys. Soc. (May 1st), "The Theory of Indentation and Hardness Tests."

[9] These "parallel" lines are really a fine criss-cross network running generally in the direction shown in Fig. 5. They appear on the top surface of chips of brass or copper, and even of stereo metal, where, of course, they cannot be due to the breaking-away of pearlite. With thin chips, cut at high speeds, lines are fine and very close together, giving a matt surface; but with thicker chips, at lower speeds, they are clearly visible to the naked eye.

[10] The relaxation time governs all problems of cooling by conduction, in the unsteady state, *i.e.*, before final equilibrium temperatures are reached. Suppose a large slab at 1000 deg. Cent. is placed in air at 0 deg. Cent. to cool. After a "long time" the temperature of the face of the slab will have cooled to a lower temperature, say, 200 deg. Cent.; provided we understand by the words a "long time," a time which is long in comparison with the relaxation time for the slab. After a "short time" (short, in comparison with the relaxation time) very little change of temperature will have taken place on the face. An absolute time of cooling, say, 1 min., may be "long" or "short" according to whether the relaxation time is one-tenth of a minute or 10 min. The "relaxation time" thus fixes a "scale" of time in these "unsteady" cooling problems. For an infinite plane slab, t cm thick, the relaxation time is $t^2/\pi^2 h^2$, where h = conductivity ÷ (density × specific heat).

[11] The symbol h^2 is used by Americans—instead of merely h—for the sake of mathematical symmetry.

led perfectly naturally to the dimensionless number vt/h^2, the reciprocal of which is a measure of the time taken by the chip to cross the contact area, in terms of the relaxation time for the chip.

The adiabatic distribution of temperature through the chip is a limiting one towards which the actual distribution of temperature tends, as vt/h^2 tends towards infinity. It depends upon the friction and the distribution of energy of plastic deformation, but, from the very definition, it is independent of vt/h^2. It is, the authors suggest, far from uniform, being greatest on the surface of the chip in contact with the tool face, and falls off rapidly through the thickness of the chip. Its exact form is, of course, unknown at present.

The actual distribution is modified towards the isothermal state as vt/h^2 falls in value, from infinity. In other word, as vt/h^2 increases, the temperature tends to the ideal adiabatic distribution, and as vt/h^2 decreases, to the isothermal. This number is, therefore, of very great significance in all problems of cutting metal where softening of the cutting edge of the tool may arise.

The thermal diffusivity, in conjunction with the thickness of the chip (t^2/h^2) furnishes an appropriate standard or unit of time (the relaxation time) in terms of which all "times" can be measured in tool problems—both the life of the tool and the transit time. Another

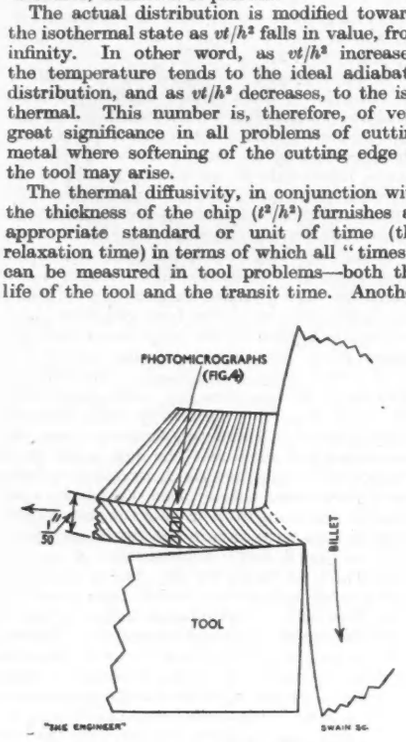


FIG. 5—*Diagram Showing Position in which Photomicrographs of Fig. 4 Were Taken*

dimensionless number is thus obtained at once—life of tool/relaxation time, *i.e.*, Th^2/t^2.

The value of h^2 for medium carbon steel is 0·0112 square foot per minute. For copper it is 0·0732 square foot per minute, *i.e.*, 6·55 times the value for steel. The significance of this fact in turning copper is obvious. The number vt/h^2 has the same value when vt for copper is 6·55 times its value for medium carbon steel; hence, for the same chip thickness, speeds can be 6·55 times as great with copper as with steel, without approaching any nearer to the adiabatic conditions for copper.

The life of the tool clearly depends on its hardness at the temperature at which it is working. Carbide holds its very great hardness up to 800 deg. Cent., whereas high-speed steel softens at about 600 deg. Cent. The much higher speeds permissible with carbide (for giving chip thickness and metal cut) depend on this increase of the softening temperature to 800 deg. Cent., whereby the tool can face temperature conditions that are probably very near the adiabatic conditions—much nearer than is possible with high-speed steel. It is possible then that only a relatively small increase in the softening temperature of carbide is needed to enable it to stand up to the limiting adiabatic conditions—at their worst—without loss of hardness. Consequently, if metallurgists can provide a material which will maintain the hardness of carbide, even only 50 deg. Cent. higher, some spectacular increases in permissible cutting speeds may be expected.

Summary of Views Put Forward.—In summary, the view offered is:—

(1) There is, in general, a gradient of temperature through the thickness of the chip over the region of contact with the tool, the highest temperatures being in the lower layers in contact with or near the tool face where the disturbance begins, and the lowest on the other surface of the chip.

(2) This inequality of temperature becomes most acute when the conditions are "adiabatic," *i.e.*, when events take place so rapidly that each element of the chip neither loses any of the heat generated in it by plastic deformation or friction, nor receives any from neighbouring metal. This happens when the time of transit over the contact area is negligible compared to the relaxation time of the chip, *i.e.*, when vt/h^2 is large, either because of very high speed or thickness or of low diffusivity of the metal cut. In such cases the maximum temperature may be considerably above the average temperature of the chip (which is nearly independent of speed, and of every other factor except the hardness of the metal cut, the tool angles, and sharpness of the tools).

(3) As the variable vt/h^2 falls in value, *i.e.*, as the time of transit becomes greater, in comparison with the relaxation time, the acute inequalities of temperature tend to adjust themselves by diffusion of temperature, and, in the limit (as vt/h^2 becomes very small), the temperature tends to become uniform—the actual temperature of the billet.

(4) The thermal "relaxation time" furnishes a natural unit of time which plays much the same part in these problems as the wavelength does, as a natural unit of length, in problems of physical optics.

(5) The dimensionless variable vt/h^2 is thus of fundamental importance in tool problems, as it determines how near the actual temperature at the bottom of the chip is to the "adiabatic" (*i.e.*, the highest possible) temperature.

(6) This dimensionless variable finds its way into other physical problems; for example, the loss of heat by forced convection and the fluctuation of temperature in cylinder walls. It will be noticed that, since h^2 has the dimensions "square feet per minute," it has the same dimensions as kinematic viscosity; indeed, vt/h^2 is Reynolds's hydrodynamical number vd/ν in a different form.

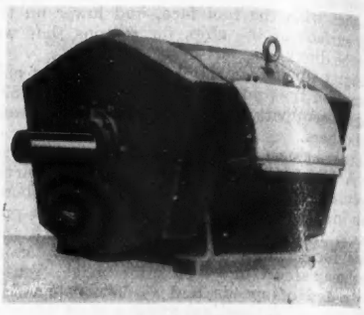
The authors then described experimental tests of actual tool life and an investigation by dimensional analysis.

Colliery Motors

THE promise of extended electrification of mines under the control of the National Coal Board gives added interest to a range of heavy-duty a.c. motors which have been developed, for colliery service, by the English Electric Company, Ltd. This range includes squirrel-cage and slip-ring motors, distinguished by the code letters "LD" and "LDS," respectively. Flameproof enclosures with Buxton certificates are available for the slip-ring machines, if required. In the standard low-voltage categories (up to 650 volts) the motors cover a range of outputs from 80 to 900 h.p. at 1500 r.p.m. and from 20 to 215 h.p. at 375 r.p.m.; synchronous speeds are quoted in both instances. Particular attention has been devoted to the production of a robust design of motor that will stand up to the arduous conditions of colliery service.

Our illustration shows a squirrel-cage motor which is typical of the new range. A drip-proof enclosure prevents the ingress of dripping water up to 15 deg. from the vertical. As shown in the engraving, this protection is achieved, without the necessity for external cavities or louvres, by inclined screen-protected openings in the bearing end plates. The stator frame is of cast iron and added strength is conferred by the small overhang of the feet. For the shaft, which is of larger diameter than is normal, 0·4 per cent carbon steel is used. Correspondingly large bearings in dustproof cartridge-type housings are used. These housings are independent of the motor end plates, so that, when the motor is dismantled for inspection or maintenance, the bearings remain protected from dust and damp.

The motors can be supplied with the stator terminal box fitted on either side of the frame. Fittings can be supplied for conduit connections; alternatively, sealing boxes are available with



HEAVY-DUTY COLLIERY MOTOR

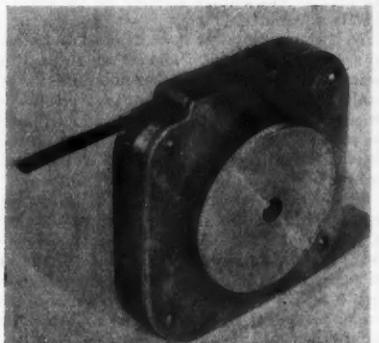
clamps suitable for P.I.L.C. cables. These fittings are made reversible, so that the cables can enter upwards or downwards, a useful degree of flexibility is given to the terminal arrangements.

A Small Vibrometer

A LIGHT, compact vibrometer, which can be carried in the pocket, has been developed by Davis, Wynn and Andrews, of Wellington Road, Cheltenham. A photograph of this instrument, which is known as the "Anson" vibrometer, is reproduced in the accompanying engraving. It utilises the principle of the vibrating reed.

The instrument consists of a strong steel case, out of one corner of which a thin steel reed can be wound by the turning of a knurled knob on one side. Variation of the cantilevered length of the overhung reed varies its natural frequency of vibration. The frequency, depending upon the position of the winding drum relative to the casing, is indicated by a calibrated dial and pointer. Just before the point where the reed emerges from the instrument body it is pressed against the case by a "node spring," and the length of reed extending beyond this spring determines its natural frequency. The reed vibrates at maximum amplitude when its natural frequency coincides with that of the body against which the instrument is held.

In use the instrument is applied at various points on a machine or piece of apparatus and the reed "tuned in" for maximum amplitude.



VIBROMETER WITH REED PROJECTING

By noting these points the sources of vibration can be readily traced. The sensitivity of the reed is such that each frequency can be segregated in the presence of other frequencies.

The small size of the vibrometer permits its introduction into restricted spaces and its light weight facilitates vibration study of small mechanisms. It is calibrated for frequencies between 3½ and 350 cycles per second or 200 and 20,000 cycles per minute.

Radio Communication in a French Marshalling Yard

For some time before the war the S.N.C.F. experimented with communication methods between a fixed point and a moving locomotive, and although interrupted by the war, in 1944 trials were resumed, resulting in the installation of a one-way system in the marshalling yard at Trappes. Trials are continuing and the system is said to be working satisfactorily.

The system comprises at the transmitting post a 25-watt transmitter, fed by current from the mains, with oscillators and tubular aerials placed at the top of a 30-m mast, and on the shunting locomotive a low-frequency amplifier with a loudspeaker fixed to the roof in the driver's cabin. A second loudspeaker is fixed to the right of the driver. An oscillator with a receiving aerial is fixed on the exterior of the locomotive at the right of the cabin roof.

The installations are fed by a battery of 24-volt accumulators supplying converters which provide the necessary h.t. current. These accumulators are charged by a 600-watt turbo-driven generator. Accumulator, battery, converter and generator are installed with the locomotive controls. The frequency is preset at 166 megacycles. The locomotive radio equipment is compact and robust, and is well protected against damp and dust. It in no way affects the driver or fireman in their duties.

Three locomotives used for shunting at Trappes are equipped in this way, and in addition, a mobile receiving station is available so that any other locomotive can be speedily equipped if one of the three are out of commission.

It is understood that since results at Trappes have been good, the S.N.C.F. now intends, in the near future, to equip many yards with apparatus permitting two-way transmission. Also, as shunting in certain yards is done by electric

RECEIVER–TRANSMITTER IN USE

or diesel locomotives, the S.N.C.F. is to equip them with similar radio apparatus to that used at Trappes. The proposed new equipment comprises a portable receiver-transmitter set which is particularly light, weighing about 1 kg, and is constructed so as not to impede movement. It has a range of 3 km to 4 km and requires less power than the original equipment.

Installations for two-way communication now tried out at Trappes comprise the small receiver-transmitter set, measuring 12 cm by 9 cm by 6 cm, working on 166 megacycles, with a microphone and earphone as illustrated herewith. One knob switches the set on and another regulates the volume. Two batteries are carried, one supplying the valve filaments, the other the h.t. current. The receiver-transmitter set is carried against the chest, whilst the batteries are carried on the operator's back.

An Extensible Conveyor

THE principle of unit construction of the "Flowline" conveyor system, designed and manufactured by Fisher and Ludlow, Ltd., Rolfe Street, Smethwick, Staffs, adapts it for a wide range of industrial purposes, particularly those involving the transporting, assembling, processing or packing of goods. One of these conveyor installations in its simplest form comprises a driving and a tension unit, between which are set a number of intermediate sections in standard lengths of 6ft. By adding or removing the supporting units and altering the length of the belt to correspond, the conveyor length can be increased or decreased quickly and easily. These conveyors are available with belt widths of 12in, 18in, 24in and 30in, and, although bitumen-impregnated belts are supplied as a standard, rubber-covered, woven wire or other types of special belt can be fitted if required.

All conveyor parts are interchangeable pressed steel components, designed for quick and easy assembly by practically unskilled labour. The belt-supporting units are actually troughs formed from a series of pressings, designed to give the maximum strength for a minimum weight. Each trough is assembled from two sides, between which are set four skid plates, the top pair of which support the belt some $\frac{3}{8}$in below the top edge of the trough. The bottom pair of skid plates forms the base and encloses the return side of the belt. Troughs can be supplied with rollers at 12in pitch, replacing the top skid plates, and the use of these rollers considerably increases the load-carrying capacity of the conveyor. The trough units are coupled together and supported by fabricated steel stands having adjustment screws in their feet for lining up a conveyor when the floor is uneven.

The standard driving unit completely encloses the motor and gearing, which are made accessible by removable covers. In this unit a crowned pulley driving the conveyor belt is chain driven through a sprocket wheel and a triple-reduction spur gear by a $\frac{3}{4}$ h.p. motor. The speed at which the conveyor belt is required to run is set at the time of installation, there being available two main speed ranges between 17·5ft and 33ft per minute and 7ft and 14ft per minute. A lay shaft can be fitted with either of these drives to give set belt speeds between 3ft and 11ft or 1·3ft and 4·7ft per minute. Although the belt speed is set at the time of installation, alternative sprockets can be readily fitted to alter the speed to any other between the set ranges of the particular drive. If required, an infinitely variable-speed driving unit can be supplied to permit a belt speed ranging from 3ft to 15ft per minute or with alternative sprocket wheels from 1·5ft to 7·5ft per minute.

The conveyor belt tensioning unit consists of a parallel pulley rotating on ball bearings on a dead shaft. Tensioning is effected by adjustment of two screws, which move the pulley shaft housings along between slider rails.

To adapt the conveyor for assembly or process work additional pressed steel units can be fitted to the sides of the troughs to form a continuous parallel bench, 15in wide on one or both sides. Alternatively, tables 3ft long and 1ft 3in or 2ft 3in wide can be fixed, projecting at right angles at the required intervals along the sides. If necessary, these tables can be assembled end to end to form a long bench at right angles to the conveyor. Pressed steel undershelves can be supplied for the tables to accommodate tools or components, and a continuous shelf can be fitted below the conveyor troughing if required. All of these tables, benches and shelves, like the troughs and their stands, are accurately drilled to permit interchangeability and easy assembly by means of bolts, screws and nuts.

Under certain conditions special components can be fitted to permit the return strand of the belt to carry work in the opposite direction to that of the top strand of the belt. A crossover unit has been designed to permit the transfer of articles where two conveyor lines are used with one set at right angles to the other.

DRIVING UNIT AND CONVEYOR ASSEMBLY LINE

Catalogues

MOND NICKEL COMPANY, Ltd., Grosvenor House, Park Lane, W.1.—Illustrated booklet entitled "Ni-Resist in the Chemical and Allied Industries."

LONDON ALUMINIUM COMPANY, Ltd., Westwood Road, Witton, Birmingham, 6.—Leaflets D.O.15 and V.S.14 on "Diamond" de-odorising plants and vacuum stills.

RANSOMES AND RAPIER, Ltd., Waterside Works, Ipswich.—Publications No. 2/442 on Rapier standard range excavators and No. 464, entitled "What We Make."

BRITISH GEAR GRINDING AND MANUFACTURING COMPANY, Ltd., Standard Road, Park Royal, N.W.10.—Booklet on precision gear grinding and other specialised services.

TEMPLEWOOD ENGINEERING COMPANY, Ltd., Eastbourne Road, Trading Estate, Slough, Bucks.—Illustrated publication, entitled "Precision Heating for Light Alloys."

WELLMAN SMITH OWEN ENGINEERING CORPORATION, Ltd., Victoria Station House, Victoria Street, S.W.1.—Illustrated export brochure, printed in four languages, giving particulars of the firm's products.

Industrial and Labour Notes

Coal Output

Figures published by the Ministry of Fuel and Power at the end of last week show that in the five-week period ended December 28, 1946, the average weekly production of saleable mined coal in Great Britain was 3,511,200 tons, compared with 3,276,600 tons in the corresponding period of 1945. The weekly average output of open-cast coal in December last was 118,400 tons. Provisional figures for January indicate that the output of saleable deep-mined coal in the week ended January 25th was 3,726,000 tons and of open-cast coal 164,400 tons. The number of wage earners on colliery books averaged 692,200 a week in December, compared with 694,900 in the same month of 1945.

The Ministry estimates that the tonnage of mined coal lost in December averaged 334,700 tons a week, of which 239,300 tons were accounted for by recognised holidays, 4500 tons by disputes, 29,300 tons by accidents, breakdowns and repairs to machinery, 58,100 tons by rail transport difficulties and lack of wagons, and 3500 tons by other causes. It should be noted that the loss through disputes was considerably lower and the loss through transport difficulties considerably higher in December than in the preceding month of November. Voluntary absenteeism among coal-face workers was 10·84 per cent in December—a little above the November figure—but involuntary absenteeism declined to 7·01 per cent. The output per manshift worked at the face in December was 2·79 tons, compared with 2·82 tons in November and 2·76 tons in December, 1945.

The total inland consumption of coal in December last averaged 3,926,000 tons a week, while overseas shipments and bunkers accounted for a further 131,000 tons. With regard to inland consumption in December, gas undertakings required an average of 506,000 tons a week; electricity undertakings, 626,000 tons; railways, 300,000 tons; coke ovens, 390,000 tons; iron and steelworks, 193,000 tons; engineering and other metal trades, 87,000 tons. A provisional estimate shows that on January 18th of this year the total distributed coal stocks were 7,081,800 tons, compared with 10,470,500 tons on January 19, 1946.

Italian Foundry Workers

Reference was made on this page of our last issue to some remarks by Sir Godfrey Ince, Permanent Secretary to the Ministry of Labour, on the difficulties of bringing Italian foundry workers to this country.

More details regarding this matter were brought to light a few days ago by the Minister of Labour in replying to a parliamentary question. The Minister said that in August, 1946, both sides of the ironfoundry industry agreed to the importation of 2800 Italian foundry workers—800 skilled men and 2000 others with substantial ironfoundry experience. After prolonged negotiations, agreement was reached last month with the Italian Government about the conditions under which the men should be recruited, and a small panel, appointed by the Minister of Supply, was now in Italy engaged in trying to obtain suitable workers. Owing to the difficulties of accommodating Italians, however, and to the comparatively small number of vacancies notified, it was expected, the Minister of Labour stated, that the numbers brought over would be much smaller than those quoted above.

Joint Negotiating Machinery

Another matter raised in Parliament last week related to the number of industries in this country without joint industrial councils or conciliation machinery. The Minister of Labour was asked what steps he proposed to take to introduce such machinery so as to reduce the risk of unofficial strikes.

In his reply the Minister said that he assumed that the question referred to either joint voluntary negotiating machinery established by agreement between the two sides, or statutory wage-regulating machinery. On that basis, according to Ministry of Labour records, about 15,500,000 workers were covered out of approximately 17,500,000 workers engaged in industry and services. The Minister could not say, with regard to the remaining 2,000,000, that no machinery of any sort existed. It had been the practice of his Department over many years to encourage and assist any industry with adequate organisation on both sides to establish joint negotiating machinery and that policy would be continued. The Minister added that, where necessary and appropriate, he would also continue the policy of setting up wages councils.

B.E.T.R.O.

The British Export Trade Research Organisation this month completes its first year of active work, and its Council has recently reported that approximately 600 overseas inquiries and research commissions have been handled. Close liaison with the export promotion department of the Board of Trade has been maintained throughout.

Many of the inquiries and commissions have come from the engineering and allied industries, information having been sought and provided on the sales possibilities of a wide range of products covering, it is stated, almost every country in the world. Norway, Sweden, Denmark and the Middle East were territories in which British manufacturers appeared to be more immediately interested in the earlier months of 1946, whilst Argentina and other South American countries were areas upon which manufacturers seemed more disposed to concentrate their longer-term plans.

American Steel Output in 1946

The American Iron and Steel Institute has recently issued some statistics relating to the operations of the steel industry in the U.S.A. during 1946. The year's production of steel ingots and castings totalled approximately 59,878,000 metric tons, a figure which was 12,740,000 metric tons below that recorded for 1945. Despite the national steel strike in the early part of 1946, and two coal strikes later in the year, steel mill operations averaged 71·6 per cent of capacity.

The Institute estimates that the American steel industry now has an annual capacity approaching 83,720,000 metric tons, which is over 6,000,000 tons greater than in 1941. In addition, a good many improvements and expansions to plant are expected to take place during this year, a sum of 327,000,000 dollars having been earmarked for the purpose by the steel companies. It is understood that an important feature of the development programme is the enlargement of the steel industry's facilities for the production of sheet and strip.

The wage bills of the industry totalled 1,500,000,000 dollars in 1946, or 9 per cent below those of 1945. The average rate paid to steel workers established a record in September last, when the figure was 136·2 cents an hour.

International Management Congress

As stated in these notes in our issue of January 3rd, arrangements are now being made for the holding of the eighth International Management Congress in Stockholm during the summer. It will open on Thursday, July 3rd, and will continue until Tuesday, July 8th.

The International Committee of Scientific Management is primarily responsible for the organisation of this Congress, and arrangements for British participation are in the hands of the British Management Council. It is felt that the Congress will provide the first post-war opportunity for many people in this and other countries to secure a swift appraisal of the principal trends and developments in management practice since 1939. The Congress programme, it may be remarked, emphasises the human and social, rather than the material, aspects of management. The three plenary sessions will be devoted to the philosophy and application of scientific management; regional and local planning in modern society; and industrial relations and the responsibilities of management and labour. There will also be fourteen sectional meetings, and amongst the subjects to be discussed at them are public and business administration, personnel selection, training and management, cost and budgetary control, production management, and quality control. In addition, visits to works and to places of general interest will be made at the end of the Congress.

Inquiries regarding British participation in the Congress should be sent to the British Management Council, 15, George Street, London, E.C.4.

Factory Allocation and Building

The Board of Trade announced on Tuesday last that, up to December 31, 1946, the total number of Government factories allocated to industrial firms or to use by the Government for training and research centres or disposal depots was 305. These factories represent an area of approximately 59,000,000 square feet, and when in full production will employ between 300,000 and 400,000 people. In the last three months of 1946, fifty-eight factories, with a total area of about 4,800,000 square feet, were allocated to industry, and these should eventually provide employment for between 13,000 and 14,000 people. In this last-mentioned group of allocations it is of interest to note that factory space has been made available to thirty-seven firms engaged in the engineering and allied industries.

With regard to the derequisitioning of factory and storage space, at the end of 1946, 160,000,000 square feet had been either returned or was in process of being handed back to industry. By the middle of this year it is expected that the return of all requisitioned factory and storage space, totalling approximately 220,000,000 square feet, will have been completed.

New factory buildings and extensions approved by the Board of Trade up to December 31, 1946, numbered 2736. It is anticipated that these will ultimately provide employment for 188,000 men and 176,000 women, and the total cost of the projects is put at £117,000,000. Of the total number of projects approved, 1085 are in the development areas and 1651 elsewhere in the country. Building has already started on 423 of the development area projects and seventy-one of them have been completed. Of the completed projects, thirty are in the North-Eastern area, five in the West Cumberland area, twenty-two in the South Wales area, two in the South Lancashire area and twelve are in Scotland.

Trade Disputes in December

There were seventy-nine industrial disputes leading to stoppages of work reported to the Ministry of Labour as beginning in the month of December, 1946, and nine stoppages which started before then were still in progress at the beginning of that month. The number of workers involved, during December, in these eighty-eight stoppages, including those put out of work at the establishments where the disputes occurred, is estimated at 18,000, and the aggregate number of working days lost at the establishments concerned was about 49,000.

Of the stoppages of work known to have been in progress at some time during December, the coal-mining industry accounted for forty-four, involving 2900 workers and resulting in an aggregate loss of 4000 working days. In the metal, engineering and shipbuilding industries seventeen stoppages were in progress in December, involving 5800 workers and causing a loss of 20,000 working days.

French Engineering News

(From our French Correspondent)

PARIS, January 31st.

SEMI-AUTOMATIC turret and capstan lathes are now being produced by the Noel Ernault factories at Lisieux. Formerly all such machines were bought abroad, but now orders are being received from Rumania, Brazil, Poland and Holland. It is hoped that these machines will offer competition to the imported models, both for quality and price. Altogether a credit of 25 million francs was voted for development of this machine, and a programme to produce twenty-five machines a month has been worked out.

* * *

The shortage of lead is causing much delay in French construction, particularly to the automobile industry. The metal is used in the manufacture of accumulators, and supplies for the first quarter are not sufficient to maintain the present output of factories.

* * *

Before the resignation of the Blum Government a decree was issued ratifying the resolutions adopted by the Modernisation and Equipment Plan and fixing the programme for 1947.

Fourteen new pits are to be sunk, ten in the north and four in Lorraine. Mechanisation is to be intensified, with electrification at the coal face, development of electric traction, larger trucks, conveyors, &c. Metallic supports are to be employed in galleries and shafts, and many modern screening and washing plants are planned to improve the quality of the coal. Finally, about 4 milliard francs will be invested in the construction of new batteries of coke ovens capable of utilising French coal hitherto not considered suitable for producing coke.

Five new thermal and eleven new hydro-electric plants will be in service this year, including that of the Aigle dam, and work on fourteen others will be started.

Ten new blast-furnaces will be installed in the north and east, and seven others reconstructed. In addition, six ore crushing installations will be constructed, four Martin ovens reconstructed, and orders will be placed for two continuous hot rolling mills, two continuous cold rolling mills and a tin plate mill.

The S.N.C.F. programme for 1947 includes the completion of the electrification of the Setes-Nimes and the Ceinture-Sud lines, preparatory work on the electrification of the Bordeaux-Montauban and Paris-Lyon lines, and the construction of 25,000 wagons, 450 coaches and 60 electric locomotives. For inland navigation the Nord-Paris route will be brought into service by dredging canals to a depth of 2·10 m, and 200 self-propelled vessels and 450 barges will be built. Three thousand three hundred new buses and 55,000 lorries of 2 tons' or greater capacity will be in use on the roads.

Altogether the year's work is expected to cost 700 milliard francs, of which 220 milliard will be spent abroad on 40,000 wagons, 12,000 tractors and machinery of all kinds.

* * *

By April, 300 oil-burning locomotives will will be in service on the lines serving the main points where oil is imported and refined, such as Marseilles, Nantes, La Rochelle, Le Havre and Strasbourg. By the end of the year 620 oil-burning locomotives will be in use in the country, effecting an economy of almost one million tons of coal. The S.N.C.F. decided to introduce oil-fired locomotives in response to the Government appeal that all available coal should be reserved for the steel industry.

* * *

Sabotage was mentioned by the Fédération Nationale de l'Eclairage et des Forces Motrices in connection with a fire at the Gennevilliers electric plant. Two 220,000-volt interruptors were completely destroyed and three-quarters of an hour later another 220,000-volt interruptor in St. Denis exploded. The Fédération considers the occurrences part of a concerted plan to sabotage production installations since nationalisation, and claims that even in thermal plants work has been held up by badly-made parts.

Notes and Memoranda

Rail and Road

RAILWAY DEVELOPMENT WORK.—Replying to a Parliamentary question, the Minister of Transport has stated that the British main line railway companies and the London Passenger Transport Board estimated that, owing to difficulty in obtaining labour and materials, they would be unable to carry out this year work to the value of £37,500,000 of the total expenditure authorised by the respective boards. Very little of this expenditure represented new capital works as distinct from replacements and reconstruction.

TRANS-AUSTRALIAN LOCOMOTIVES.—The report of railway operations in the Commonwealth of Australia during the year 1945–46 states that an investigation has been completed into the desirability of replacing steam locomotives on the Trans-Australian Railway with diesel-electric locomotives. Since the close of the financial year, tenders have been called for two, or alternatively four, diesel-electric locomotives of 1000 h.p. each. It is proposed to use these locomotives between Port Pirie Junction and Tarcoola, a distance of 314 miles. Their performance and saving in operating costs as against steam locomotives will be closely studied, it is reported, with a view to extending the use of diesel locomotives.

DALTON TUNNEL, L.M.S.—The up and down tracks of the London, Midland and Scottish Carnforth and Barrow-in-Furness line have been interlaced for a distance of approximately 320 yards through Dalton tunnel—between Dalton Station and Park Junction—whilst relining of the tunnel is in progress. This method of working, involving special temporary signalling arrangements for single-line working through the tunnel, and minor adjustments in the timings of between seventy and eighty daily trains, which normally might cross one another in the tunnel section, has been adopted in order to afford adequate clearance for the erection of scaffolding in the tunnel. The Dalton tunnel is over 100 years old, having been opened with the original sections of the Furness Railway in 1846.

Miscellanea

ATOMIC POWER.—Owing to continued public interest, the "March of Time" film, entitled "Atomic Power," will continue to be shown at the Science Museum, South Kensington, S.W.7, for a further four weeks until February 23rd, by courtesy of 20th Century Fox Film Company, Ltd. The film, which tells the story of the way in which atomic energy has been released and utilised, is being shown on week-days at 2.30 p.m. and on Sundays at 3.15 and 4.15 p.m. Admission is free.

GERMAN TECHNICAL INTELLIGENCE.—With reference to the publication by the British Intelligence Objectives Sub-Committee of Reports on German Industry, and in connection with the exhibition on this subject which is now touring certain regional centres, the Board of Trade wishes to point out that, although no invention made in Germany during the period between September 3, 1938, and December 31, 1945, can become the subject of a valid British patent, nevertheless some of the information gathered in Germany may be covered by valid patents or patent applications in the United Kingdom. In order to avoid infringing patent rights, therefore, firms interested in exploiting any particular item are advised to investigate the patents position in the United Kingdom before going into production. Similar investigations are also desirable before exports are made to any particular country abroad.

THE LATE MR. H. HOLDEN.—We have learned with regret of the death on December 16th last, of Mr. Harry Holden, joint founder of Holden and Brooke, Ltd., Manchester. Mr. Holden, who was eight-eight years of age, was educated at Repton and served his apprenticeship with Sharpe, Stewart and Co., Ltd., locomotive builders. In 1881 he began business in Salford on his own account under the style of the Broughton Manufacturing Company, and two years later Mr. Robert Brooke—a fellow-apprentice—joined him to form the firm of Holden and Brooke. Their object was the development of the manufacture of the steam ejector. Both founders were closely associated with the business until Mr. Brooke's death in 1929, and Mr. Holden then took over the chairmanship, a post from which he did not retire until 1944, when he was succeeded by his old partner's elder son, Mr. G. Brooke.

AMERICAN HELIUM SALES.—According to a statement by the U.S. Bureau of Mines, Government sales of helium to commercial users in the United States are expected to average more than one million cubic feet monthly during the fiscal year 1947, the greatest volume of the gas ever used industrially. The industrial demand has been increased by the development of a process for welding aluminium by helium-shielded arc welding. During the war, magnesium was virtually the only metal welded by helium-shielded arc welding because of difficulties experienced in welding aluminium in this manner. However, these obstacles have been surmounted and more and more aluminium fabricators are utilising helium in welding processes.

TIN METAL ALLOCATIONS.—The Ministry of Supply has now announced more details of the allocations of tin metal made by the Combined Tin Committee in Washington. At a recent meeting the Committee recommended that, in view of statistical uncertainties regarding the supply position, but having regard to the need to keep supplies moving, only interim allocations of tin metal for the first half of 1947 should be made at present amounting to approximately 50 per cent of the allocations recommended for the last half of 1946. These interim allocations, which do not include domestic production, are not to be regarded as constituting a pattern for final allocations. At a later date substantial additional quantities of tin will be available for allocation. During the first half of this year the interim allocations amount to 10,915 long tons, the principal quantities being U.S.A., 3640 tons; France, 2275 tons; and India, 1140 tons.

THE CHEMICAL SOCIETY'S CENTENARY.—To commemorate the centenary of the Chemical Society, which was founded at a meeting in the rooms of the Society of Arts, a special joint meeting of the two societies will be held at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2, on Wednesday, February 19th, at 5 p.m. War conditions prevented the Chemical Society from celebrating the hundredth anniversary of the first meeting, held on February 23, 1841. It was on that date that the decision was taken "that it is expedient to form a Chemical Society," and Professor Thomas Graham was elected the first President. The Chemical Society continued to meet at the Society of Arts for some years, but, as the Fellowship expanded it became necessary for it to seek premises of its own. The first permanent home which the Society found was at 142, Strand, two years after its incorporation by Royal Charter in 1848. At the commemorative meeting the Right Hon. Viscount Bennett, P.C., K.C., LL.D., President of the Royal Society of Arts, will take the chair, and Sir Harold Hartley, F.R.S., will lecture on "A Century of Chemistry."

B.I.O.S. EXHIBITION.—The British Intelligence Objectives Sub-Committee Exhibition, which was held at the Board of Trade, Millbank, in December last, is now touring the principal regional centres. The following dates and places have been arranged for the provincial tour of this exhibition:—Cardiff, University College, Cathays Park, February 17th to 21st; Glasgow, Kelvin Hall, March 3rd to 7th; Newcastle, Chronicle Hall, Westgate Road, March 17th to 21st; Sheffield, City Hall, March 31st to April 4th; Manchester (location not yet fixed), April 14th to 18th; and Belfast, Technical College, May 5th to 9th. The exhibition is designed to illustrate the methods by which German scientific and technical intelligence is gathered, how it is dealt with, and, finally, how the individual industrialist with his own problems to solve may avail himself of the information he requires. It is appreciated that many firms have not the necessary staff available to examine the whole range of reports relating to their particular industries from amongst the vast amount of information already available and yet to be published, and B.I.O.S. information section, 37, Bryanston Square, London, W.1, was set up some months ago to perform this service on behalf of industry. In addition to dealing with inquiries arising out of reports published by His Majesty's Stationery Office, the B.I.O.S. information section has access to a considerable number of site reports on German factories and research establishments, original German documents, and miscellaneous items of information which, by their nature, are not suitable for reproduction and publication by His Majesty's Stationery Office. All inquiries about German technical processes covered in the reports, as well as requests for information which may otherwise be available in the United Kingdom should be directed to B.I.O.S. information section at the above address.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Tuesday, Feb. 18th.—Lighting Service Bureau, 2, Savoy Hill, W.C.2. "The Electrical Equipment of a Modern Hospital," J. Tomlinson. 6.15 p.m.

Bradford Engineering Society

Monday, Feb. 17th.—Technical College, Bradford. "Electrical Driving for Textile Machinery," A. J. Francis. 7.15 p.m.

Chemical Engineering Group

Friday, Feb. 14th.—Geological Society, Burlington House, Piccadilly, W.1. "Polyvinyl Chloride and its Co-Polymers," G. Eyssen. 5.30 p.m.

Chemical Society

Thursday, Feb. 13th.—BRISTOL BRANCH: The University, Woodland Road, Bristol. Discussion, "Protein Chemistry." 2.15 p.m.

Wednesday, Feb. 19th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "A Century of Chemistry," Sir Harold Hartley. 5 p.m. (Joint meeting.)

Thursday, Feb. 20th.—Burlington House, Piccadilly, W.1. "The Reduction of Oxides by Hydrogen and Carbon Monoxide," W. E. Garner; "The Photo-chemical Polymerisation of Vinyl Acetate Vapour," H. W. Melville and R. F. Tuckett; "Radical Sensitised Polymerisation of Vinyl Acetate Vapour," H. W. Melville. 7.30 p.m.

Derby Society of Engineers

Monday, Feb. 10th.—School of Arts, Green Lane, Derby. "Production of Armaments by Unskilled Labour," F. Gudgeon. 7 p.m.

Illuminating Engineering Society

To-day, Feb. 7th.—BIRMINGHAM CENTRE: Imperial Hotel, Temple Street, Birmingham. "Some Recent Trends in Daylighting," W. A. Allen. 6 p.m.

Tuesday, Feb. 11th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "The Brightness and Legibility at Night of Road Traffic Signs," J. S. Smyth. 6 p.m.

Institute of Marine Engineers

Tuesday, Feb. 11th.—85, The Minories, E.C.3. "Fundamentals of Ship Stability," J. S. Redshaw. 5.30 p.m.

Thursday, Feb. 20th.—85, The Minories, E.C.3. Films, "Kelvin—Master of Measurement" and "Romance of Engineering." 7 p.m.

Friday, Feb. 21st.—S. WALES BRANCH: Technical College, Swansea. "Gas Turbine Design and Operation," A. T. Bowden. 7 p.m.

Thursday, Feb. 27th.—JUNIOR SECTION: East Ham Technical College, Barking Road, E.6. "The Production of Oil Fuel," J. S. Jackson. 7 p.m.

Institute of Physics

Wednesday, Feb. 12th.—SHEFFIELD BRANCH: The University, Sheffield. "Physics and Steel Making," C. Sykes. 5.15 p.m. (Joint meeting.)

Institute of Refrigeration

Tuesday, Feb. 11th.—Inst. of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1. "A Low-Temperature Test Station for Heavy Military Equipment," P. T. Fletcher, H. R. Swatman and S. A. Wood. 5.30 p.m.

Institution of British Agricultural Engineers

Tuesday, Feb. 18th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Milking Machines," H. P. Hall. 2 p.m.

Institution of Civil Engineers

Tuesday, Feb. 11th.—Great George Street, S.W.1. "Training of Foremen for Civil Engineering Work," A. M. Holbein; and "The Training of Inspectors for Civil Engineering Work," A.A. Symington. 5.30 p.m.—S. WALES ASSOC.: Talbot Hall, Mackworth Hotel, Swansea. "The Application of Soil Mechanics to Highway Construction," D. I. Richards. 6 p.m.

Thursday, Feb. 13th.—BIRMINGHAM ASSOCIATION: James Watt Memorial Institute, Great Charles Street, Birmingham. "West Middlesex Main Drainage—Ten Years' Operation," C. B. Townend.

Institution of Electrical Engineers

To-day, Feb. 7th.—S. MIDLAND CENTRE: Grand Hotel, Birmingham. Annual dinner. 6.30 p.m.

Monday, Feb. 10th.—N. EASTERN CENTRE: Neville Hall, Newcastle-on-Tyne. "Growing Importance of Plastics in the Electrical Industry," G. E. Haefely. 6.15 p.m.

Tuesday, Feb. 11th.—N. MIDLAND CENTRE: Corporation Electricity Department, Whitehall Road, Leeds. "A Survey of the Development of Radar," R. A. Smith. 6 p.m.—N. IRELAND CENTRE: Queen's University, Belfast. "Industrial Applications of Electronic Techniques," H. A. Thomas. 6.45 p.m.

Wednesday, Feb. 12th.—SCOTTISH CENTRE: Heriot-Watt College, Edinburgh. "A Survey of the Development of Radar," R. A. Smith. 6 p.m.

Wednesday, Feb. 19th.—RADIO SECTION: Savoy Place, Victoria Embankment, W.C.2. "The Design of High-Fidelity Disc-Recording Equipment," H. Davies. 5.30 p.m.—N. EASTERN CENTRE: Literary and Philosophical Society, Newcastle-on-Tyne. "The Generation and Wholesale Distribution of Electricity," J. Hacking. 7 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Feb. 18th.—39, Elmbank Crescent, Glasgow. "Some Notes on Propeller Theory," L. C. Burrill. 6.30 p.m.

Institution of Engineers-in-Charge

Wednesday, Feb. 12th.—St. Bride Institute, Bride Lane, Fleet Street, E.C.4. "Present and Future Laundry Problems," F. L. Mason. 6.30 p.m.

Institution of Heating and Ventilating Engineers

Monday, Feb. 17th.—N.E. COAST BRANCH: Inst. of Mining and Mechanical Engineers, Neville Hall, Newcastle-on-Tyne. "Fans and their Applications," Mr. Donaldson. 6.30 p.m.

Tuesday, Feb. 25th.—SCOTTISH BRANCH: Inst. of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. "Modern Electric Panel Heating," A. C. F. Mackadam. 7.30 p.m.

Wednesday, Feb. 26th.—LIVERPOOL BRANCH: Accountants' Hall, Fenwick Street, Liverpool. "Steam Raising and Hot Water Supply by Electrode Boilers," E. Covington. 6.30 p.m.

Institution of Mechanical Engineers

To-day, Feb. 7th.—Storey's Gate, S.W.1. "Basic Principles of Automatic Control Systems," A. Porter. 5.30 p.m.

Tuesday, Feb. 11th.—S. WALES BRANCH: Institute of Engineers, Park Place, Cardiff. "Recent Developments in Flying-Boats," H. Knowler. 6 p.m.—MIDLAND BRANCH: Queen's Hotel, Birmingham. Annual dinner. 6.45 p.m.

Monday, Feb. 17th.—GRADUATES' SECTION: Storey's Gate, S.W.1. "The Art and Mechanism of Weaving," Ian S. Porter. 6.30 p.m.

Tuesday, Feb. 18th.—Storey's Gate, St. James's Park, S.W.1. "The Flow of Metals," Dr. A. Nadai. 3 p.m. and 5.30 p.m.

Thursday, Feb. 20th.—MANCHESTER BRANCH: College of Technology, Sackville Street, Manchester. "The Flow of Metals," A. Nadai. 2.30 p.m. and 5.30 p.m.

Friday, Feb. 21st.—Storey's Gate, St. James's Park, S.W.1. "The Development of Locomotive Power at Speed," E. L. Diamond. 5.30 p.m.

Institution of Mining Engineers

Wednesday, Feb. 12th.—Geological Society, Burlington House, Piccadilly, W.1. Annual general meeting. Paper, "Progress in Coal Preparation Practice," A. Grounds and W. Reed. 11 a.m.

Institution of Post Office Electrical Engineers

Tuesday, Feb. 11th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Development of Telephone Transmission Over Lines in the Last Forty Years," R. M. Chamney. 5 p.m.

Institution of Production Engineers

Wednesday, Feb. 12th.—LUTON SECTION: Central Library, Luton. "Measurement of Surface Finish," C. Timms. 7 p.m.

Thursday, Feb. 13th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "Cold Forging," C. J. Whitcombe. 6.30 p.m.

Saturday, Feb. 15th.—YORKSHIRE GRADUATES: Great Northern Hotel, Bradford. "Cost Control as an Aid to Management," R. Cooper. 2.30 p.m.

Monday, Feb. 17th.—DERBY SUB-SECTION: School of Arts, Green Lane, Derby. "Motion Study," Miss Shaw. 6.45 p.m.—HALIFAX SECTION: Whiteley's Café, Westgate, Huddersfield. "The Manufacture of Seamless Steel Tubes," J. W. Jenkin. 7 p.m.

Wednesday, Feb. 19th.—N.E. SECTION: Neville Hall Mining Institution, Newcastle-on-Tyne. "Apprentice Training," W. A. Hildrow and G. M. Baker. 6.30 p.m.—PRESTON SECTION: Clayton, Goodfellow and Co., Ltd., Blackburn. "Modern Heat Treatment," A. G. McDonald. 7.15 p.m.—SHEFFIELD SECTION: Royal Victoria Hotel, Sheffield. "Furnaceless Heating by Town's Gas," J. F. Waight and J. Palser. 6.30 p.m.—BIRMINGHAM SECTION: James Watt Institute, Great Charles Street, Birmingham. "Apprentice Training," Lieut. R. T. M. Toyn. 7 p.m.

Thursday, Feb. 20th.—GLASGOW SECTION: Inst. of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. "The Application of Production Standards in Industry," H. G. Houghton. 7.30 p.m.—LEICESTER SECTION: College of Technology, Leicester. "Fabrication Design as a Substitute for Castings," F. G. Rout. 7 p.m. (Joint meeting.)

Friday, Feb. 21st.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol. "High-Frequency Induction Heating," S. Cosgrave. 6.45 p.m.

Junior Institution of Engineers

Monday, Feb. 10th.—N. WESTERN SECTION: Geographical Society, 16, St. Mary's Parsonage, Manchester. "Starting a Small Engineering Business," F. Burgess. 7 p.m.

Wednesday, Feb. 12th.—SHEFFIELD SECTION: Royal Victoria Hotel, Sheffield. Presidential Address, "Inspection," A. W. Sproull. 7.15 p.m.

Friday, Feb. 14th.—39, Victoria Street, S.W.1. Chairman's Address, "Windmills," Rex Wailes. 6.30 p.m.

Keighley Association of Engineers

Friday, Feb. 14th.—Devonshire Buildings, Devonshire Street, Keighley. "Refrigeration," J. Orpin. 7.30 p.m

Manchester Association of Engineers

Friday, Feb. 21st.—Engineers' Club, 17, Albert Square, Manchester. "Oilfield Drilling and Production Practice in Great Britain," R. K. Dickie. 6.45 p.m.

Manchester Geological and Mining Society

Tuesday, Feb. 11th.—Engineers' Club, Albert Square, Manchester. "The Organisation of a Planning Department, and Planning Methods," F. Marsh. 3.15 p.m.

Newcomen Society

Wednesday, Feb. 12th.—Iron and Steel Institute, 4, Grosvenor Gardens, S.W.1. "Malham Moor Mines, 1790–1830," A. Raistrick; and "The Development of the Bessemer Process in Lancashire, 1856–1900," W. M. Lord. 5.30 p.m.

Royal Institution of Chartered Surveyors

Monday, Feb. 17th.—12, Great George Street, S.W.1. "Provisions of the Town and Country Planning Bill," Right Hon. Lewis Silkin, M.P. 5.30 p.m.

Royal Institution of Great Britain

To-day, Feb. 7th.—21, Albemarle Street, W.1. "Vitalism: Old and New," James Gray. 9 p.m.

Friday, Feb. 14th.—21, Albemarle Street, W.1. "Natural Science and the Fine Arts," F. I. G. Rawlins. 9 p.m.

Friday, Feb. 21st.—21, Albemarle Street, W.1. "Problems and Techniques of Modern Nuclear Physics," M. L. Oliphant. 9 p.m.

Royal Society of Arts

Wednesday, Feb. 19th.—John Adam Street, Adelphi, W.C.2. "Modern Astronomical Instruments," Sir H. Spencer Jones. 5 p.m.

Sheffield Metallurgical Association

Tuesday, Feb. 11th.—198, West Street, Sheffield. "Trends in Furnace Design," H. Southern. 6.30 p.m.—REFRACTORIES GROUP: Mappin Hall, The University, St. George's Square, Sheffield. "A Statistical Sampling Plan for Refractory Products," W. T. Hale. 7 p.m. (joint meeting).

Personal and Business

MR. W. THOMAS has joined the staff of F. Perkins, Ltd., Peterborough.

MR. ANDREW MCCOSH has been appointed a director of Bairds and Scottish Steel, Ltd.

MR. ALEC WEBSTER has been appointed safety officer of the Association of British Chemical Manufacturers.

MR. W. B. BAMFORD has been appointed to take charge of the non-ferrous metals branch of Thos. W. Ward, Ltd., Sheffield.

THE COLONIAL OFFICE announces the appointment of Mr. J. S. Robertson as district engineer on the Malayan Railways.

DR. R. C. G. WILLIAMS, M.I.E.E., has joined the staff of the North American Philips Company, Inc., New York, as executive engineer.

THE BIRTLEY COMPANY, Ltd., has set up an organisation at Market Place Chambers, Chesterfield, to deal with coal-preparation plant.

ELECTRIC AND GENERAL INDUSTRIAL TRUSTS, Ltd., has acquired the whole of the capital of Simmonds Aerocessories, Ltd., and Simmonds Products, Ltd.

FERODO, Ltd., has transferred its London depot to Ferodo House, 10–12, Handel Street, W.C.1 (telephone, Terminus 8181; telegrams, Frodobrake, Phone, London).

MR. ALAN P. GOOD has resigned from the boards of Tarran Industries, Ltd., and Folland Aircraft, Ltd., in order to concentrate his activities with the Brush Electrical Engineering Company, Ltd.

MR. CHARLES E. BELL has been appointed secretary of the High-Speed Steel Association, with offices at Corn Exchange Buildings, Sheaf Street, Sheffield, 2 (telephone, Sheffield 27536).

MR. G. WILSON has been elected President, and Mr. C. Douglas Terry and Mr. J. Y. Sangster have been elected Vice-Presidents of the British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd.

SIMMONDS AEROCESSORIES, Ltd., has transferred its head office and research departments to the works at Treforest, near Pontypridd, Glamorgan. The London office will remain at 2–3, Norfolk Street, Strand, W.C.2.

MR. W. H. DONALD has been appointed mains transmission engineer of the Bristol Corporation electricity undertaking. Mr. G. E. Black has been appointed shift control engineer at the Portishead power station of the Bristol undertaking.

MR. S. J. WRIGHT, M.A., Director of the National Institute of Agricultural Engineering, Askham Bryan, since its foundation in 1942, is shortly relinquishing that position to take up an appointment with the Ford Motor Company, Ltd.

MR. I. A. MARRIOTT has been appointed a local director of the Brush Electrical Engineering Company, Ltd. The sales staffs of this company and of Associated British Oil Engines, Ltd., will work under his direction as a combined organisation.

Contracts

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., announces that its associated company, Marconi Espanola, has obtained a contract worth 12,000,000 pesetas (approximately £270,000) for the supply of four powerful short-wave broadcasting transmitters to the Spanish State broadcasting service. The transmitters, each rated at 100 kW, are to be of the Marconi type TBS.802, and their manufacture, assembly, testing and installation will be carried out by the Madrid and Chelmsford factories working in close collaboration.